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THE EXTERNAL MORPHOLOGY OF SOME OF THE DIPTEROUS LARVAE LIVING IN THE GRAMINEAE OF BRITAIN[1]

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E.M.N.

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With 109 Text-figures

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I. Introduction

The present study is the first part of a general investigation into the systematics and ecology of insects associated with graminaceous plants, with particular reference to shoot flies and stem borers of cereal crops of the Palaearctic and Ethiopian regions. It is the object of this paper to facilitate the identification of the commoner cyclorrhaphous larvae, with the exception of those of the Agromyzidae, which are to be found boring in the stems of British grasses and cereals.

[1] This paper comprises part of a thesis submitted to the University of London in part fulfilment of the requirements for the degree of Doctor of Philosophy.

[2] Now at the Commonwealth Institute of Entomology.

It is the larval instars which are always found causing damage in the field and it is at this stage that the agriculturalists wish to be able to identify them. The inability to do so has led to the ascribing of attacks on cereal crops to one of the well known species such as the Frit Fly, *Oscinella frit* L., or the Wheat Bulb Fly *Leptohylemyia coarctata* Fallén when in fact a complex of species is often involved.

Previous workers have monographed individual or small groups of these larvae, but there have been only two accounts of the group as a whole. The first, Kreuter (1928), gives very short notes on the bionomics and morphology of 15 species with sketches of some of their eggs, larval spiracles and cephalopharyngeal skeletons. The second, Chapter 3 of *Les insectes nuisibles aux plantes cultivées* by A. Balachowsky and L. Mesnil (1935), is far more complete and covers double the number of species in much greater detail. These and the other contributions are reviewed in the following pages under the species concerned.

II. Material and Methods

The specimens described have mainly been obtained in and around the Imperial College Field Station, Silwood Park, Sunninghill, Berkshire. Silwood Park lies on the Bagshot beds and has a poor, sandy soil with a ground cover, in the open land, of *Festuca rubra* L., *Agrostis tenuis* Sibth., *A. canina* L., *Holcus lanatus* L., *H. mollis* L. and clumps of *Arrhenatherum elatius* L. Other specimens sent in for identification from different parts of the British Isles have been closely examined and the variation they exhibited has not been found to differ to any great extent from the Silwood populations. Individual variation between larvae is noticeable when studying their small cuticular structures, and for the differentiation of species more than one specimen should be examined.

The extraction of larvae using apparatus of the Berlese funnel type by means of heat, or by irritants such as turpentine vapour, proved unsuccessful. The only satisfactory method was the individual dissection of stems carried out under a stereo-microscope. Very fine stainless steel forceps were found to be ideal instruments.

The larvae were kept in covered watchglasses containing tap-water until identified. Except for *Hydrellia incana* Stenhammar they sank and could not crawl out, and apart from this species they could be left thus for several days or even up to a month (with increasing mortality). In warm weather mortality was decreased by keeping them at a temperature just above freezing.

For detailed examination of fresh material the larva was mounted in water between slide and cover slip and examined under the low and high power of a research microscope. Transmitted light from an intensity lamp focused to give Kohler illumination, together with a blue filter, was the most satisfactory. If the larva was too active it was found best to kill it by pressing the ends of the slide on to a hot bench lamp with the forefingers until it became almost too hot to bear; the slide was then removed. If thus heated to thermal death point, the larva remained clear, but if overheated the proteins of the body contents coagulated and the mount became opaque.

The puparium has the same facies as the larva from whose cuticle it is formed, and when empty it can be immersed in absolute alcohol or euparol

essence and the air within it gradually squeezed out. It may then be mounted in balsam or euparol and examined (after allowing time for uniform diffusion to take place). Although the facial mask is retracted and entirely lost, the cephalo-pharyngeal skeleton, spiracles and spicular zones may then be examined and used for identification. This is especially useful in the confirmation of the identity of parasite hosts.

The figures were made with the aid of a camera lucida. Particular care was taken to ensure that all drawings of the critical features of the larvae were from identical aspects. A strict comparison between species, not possible previously, can therefore now be made.

All the illustrations are of third instar larvae and are diagrammatic ; they do not pretend to portray the exact number of spicules and very fine detail present. The detailed descriptions and drawings were prepared after examination of many individuals of each species and represent typical specimens. Notes on the minor individual variation encountered are given wherever important.

III. General External Morphology of the Third Instar Larvae

(1) *General Description*

All the species under consideration belong to the series Acalypterae and Calypterae and in every known case the life history consists of the egg, three larval instars, puparium and the imago. Of all the immature stages it is in the third instar larvae that the characteristic morphological differences between species are most fully developed, and for this reason this stage is being described in detail.

Typical third instar larvae vary according to species, in length from 4 to 10 mm., in diameter from 0·5 to 1·2 mm. and in colour from white, through creamy white to pale yellow (except for *Meromyza* spp. which are pale green) and are more or less translucent depending on the amount of fat body reserves present. The malpighian tubules are often visible in part as deep yellow intertwining threads. The larvae are apodous, free of cuticular outgrowths, except in some families at the posterior, and approximate in shape to a cylinder slightly flattened dorsoventrally, tapering anteriorly and more broadly rounded posteriorly.

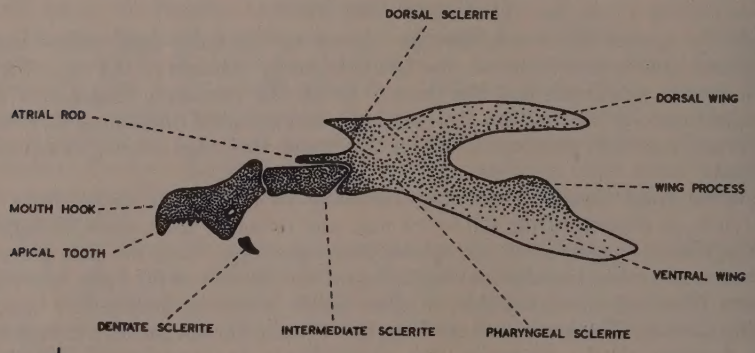
The antennae are at the extreme anterior of the head (except for *Chlorops* spp. in which they are lateral) but, in general, at low magnification further cephalic characters, apart from the heavily sclerotised mouth-hooks, cannot be identified.

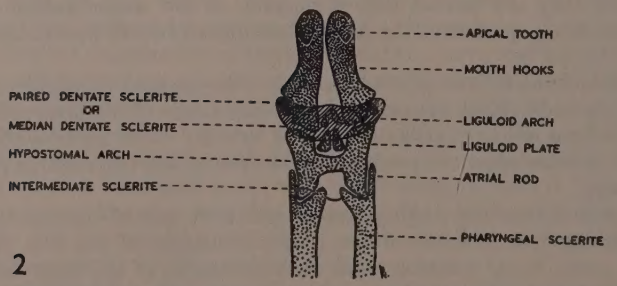
The head and the following 11 segments are demarcated by slight constrictions round the body. Each segment usually bears a zone of transverse cuticular ridges in the form either of striae or rows of spicules which encircle the body to a greater or lesser extent depending on the species and the relative position of the segment.

Third instar larvae are amphipneustic and have paired digitate anterior spiracles opening just in front of the posterior margin of the first thoracic segment. A main dorsal tracheal trunk runs the length of the body and joins the anterior to the posterior spiracle which opens to the exterior, often on a spiracular lobe, at the end of the abdomen.

(2) *The Cephalo-pharyngeal Skeleton.* (Figs. 1, 2)

In the cyclorrhaphous larva the highly modified ectodermal cephalo-pharyngeal skeleton consists mainly of paired sclerites. Anteriorly there is a pair of *mouth-hooks*, both working together in a vertical plane and each with an apical tooth followed by a variable number of smaller teeth. Posteriorly each mouth-hook articulates with an *intermediate sclerite*, and these two are joined ventrally by a *hypostomal arch*. The intermediate sclerites are more or less fused with a large paired *pharyngeal sclerite*, each side of which may be divided into a *dorsal wing* and a *ventral wing* joining anteriorly, and giving rise to an anterior prolongation of the ventral wing, the *atrial rod*, over part of the intermediate sclerite. More or less fused anterodorsally to each of the pharyngeal sclerites is a median *dorsal sclerite*. In some genera there is, on the top of the ventral wing, a *wing process*. In addition to the main sclerites there are a few other smaller pieces which enter into the structure of the skeleton. The most important of these taxonomically are the *dentate sclerites*, which are usually situated ventrally to each mouth-hook but in some genera the pair are fused to form a single *median dentate sclerite*. An intermediate condition





FIGS. 1–2.—(1) Generalised cephalo-pharyngeal skeleton, lateral view; (2) the same, ventral view.

can be seen in *Palloptera*, where the dentate sclerites are large and almost fuse along the mid-ventral line. Dorsal to these sclerite(s), and between the mouth-hooks, a narrow strap-like *liguloid arch* can sometimes be seen, and lying between this arch and the hypostomal arch are a pair of small *liguloid plates*.

These are the only sclerotised skeletal structures in the body and their phylogeny has been a controversial topic since they were first described by Leuckart (1863). Historical surveys of the literature on this subject have been included in the works of Cook (1949) and Ludwig (1949).

In the most recent work embracing all the known dipterous larvae, Hennig (1948–52) assesses and reviews the interpretations of previous authors and links them with his own findings. More recently Snodgrass (1953) discusses the metamorphosis of the head of a fly.

(3) *The Head and Facial Mask.* (Fig. 3)

All the morphological characters associated with the head are concentrated on the ventral and, to a lesser extent, the lateral aspect and collectively form the *facial mask*. Anteriorly there is a pair of two-segmented, usually unsclerotised *antennae* consisting of a basal, and an apical generally ovoidal segment. Just posterior to the antennae, or level with them in *Chlorops*, is a pair of prominent *maxillary palps*, each usually formed of a somewhat sclerotised ring. Whilst in some genera this ring is complete, in many it is incomplete anterolaterally, and is then termed an open type. The ring, whether open or not, usually contains from four to six papillae, with a further pair lying anterolaterally either just outside the ring or just beyond its open ends. These two organs are closely associated in the Calliphoridae, on which most of the work on cyclorrhaphous larvae has been done, and they are together termed the antenno-maxillary complex. Weismann (1864) homologised the two with their more primitive structures and considerable controversy has since arisen on this point. Ludwig (1949) is in agreement and has shown the antenna to be innervated by a branch from the antennal-labral nerve, while the maxillary palp is innervated by a branch from the mandibular-maxillary-labial nerve.

There is a further small palp lying between the maxillary palp and the mouth-hooks ; this palp is a very insignificant structure in the Calypterae and has so far received little attention by morphologists. In the Acalypterae, on the other hand, it is better developed and often forms a feature of taxonomic importance. Although it would be convenient to follow Mesnil (1934) in calling this the labial palp, the later work of Cook (1949) indicates that the labium of the cyclorrhaphous larva is greatly reduced. Ludwig (1949), in the case of *Calliphora erythrocephala* Meig., has shown this palp to be innervated by a branch of the maxillary nerve and, although the latter eventually joins the labial nerve, this palp is more closely associated with the maxillary palp than with the labium. Until such time as its relations with the labium are more definitely established it should be designated the *frontal palp* and the three or four cells of which it is comprised, the *frontal papillae*. The reduced labium itself can usually be seen as a small sclerite lying immediately posterior to the mouth opening, and is termed the *labial plate*, and on it there are two pairs of *labial pores* which might more reasonably be regarded as the true remnants of the labial palp.

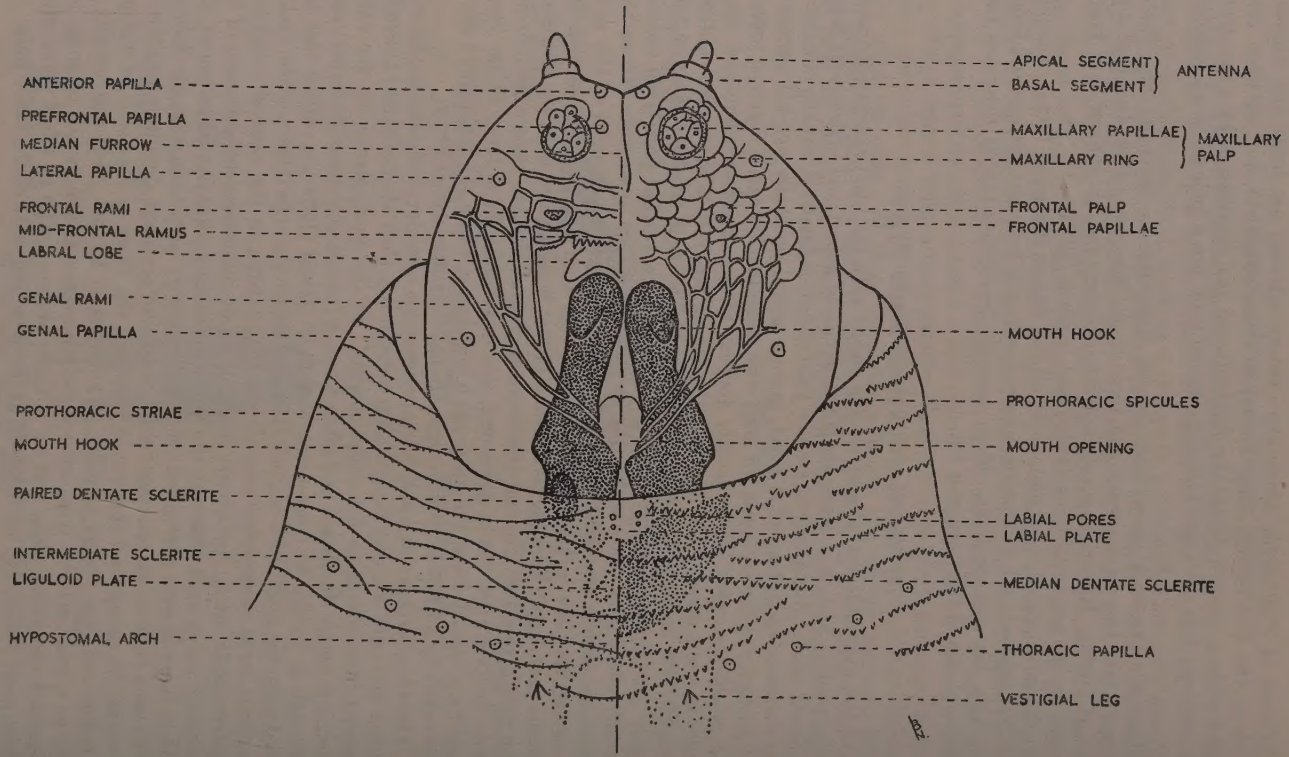


FIG. 3.—Composite diagram of facial mask.

On the facial mask there are four pairs of *cephalic papillae* which are named individually according to their position as *anterior*, *pre-frontal*, *lateral* and *genal papillae*. As in the case of the antennae and the maxillary and labial palps, the function of these structures is unknown although they are assumed to be sensory.

Immediately anterior to the mouth-hooks and partially surrounding them are the *labral lobes*, which appear to assist in the channelling of food particles rasped off by the mouth-hooks into the mouth opening lying between them. This channelling of food particles is assisted in addition by the *cephalic rami*, which appear to be colourless cuticular thickenings. These commence in the mouth opening between the mouth-hooks and run anteriorly, bifurcating and anastomosing to form the main features of the facial mask, mainly within the area bounded by the cephalic papillae. The rami may in part or whole be plain, crenulate, serrate or toothed and are in number and arrangement extremely variable from genus to genus. The small areas bounded by the rami are termed *cephalic cells* and their arrangement and size is entirely determined by the rami. To facilitate the description of diagnostic features these rami are divided into three broadly defined areas : the *mid-frontal rami* lying between the frontal palps, the *frontal rami* on the three outer sides of the frontal palps, and the *genal rami* lying in the area between the genal papillae and the mouth-hooks.

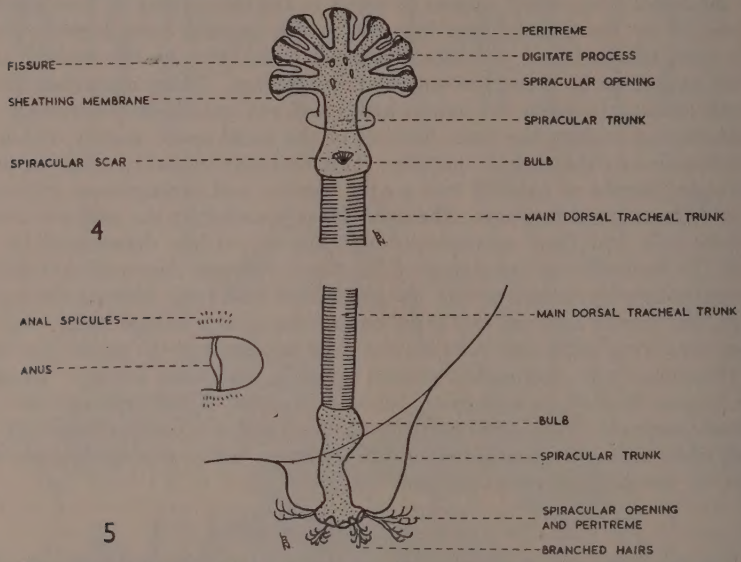
Occasionally in thoroughly relaxed or dead specimens a long " tongue " can be seen everted, in side view, between the base of the head and the first thoracic segment. This is normally invaginated and is a pouch of spare cuticle used, when the head is withdrawn into the thorax either as a distaste reaction or in the formation of the puparium.

(4) *The Thorax and Abdomen.* (Figs. 3–7)

The three thoracic segments are each characterised, in all the species which have been examined, by a mid-ventral pair of small *vestigial legs* consisting of a group of three closely apposed papillae, each bearing a minute seta. Keilin (1915) has established the homology of these structures, which he has found to be in direct relation with the imaginal discs of the legs. In some species a line of six to eight *thoracic papillae*, similar to the cephalic papillae, can be seen in the thoracic segments, and likewise *abdominal papillae* in some abdominal segments.

Encircling the anterior of the first thoracic segment is a *spicular zone*, consisting either of a series of irregular rows of spicules arranged in loose groups or of a series of overlapping striae which are usually finely serrated ; the type and number of rows depends upon the species. These bands are in general repeated in each segment of the body, though the nature of the spicules and their arrangement often vary down the length of the larvae and will be discussed for each species. The spicules themselves may be classified roughly into a series of intergrading types which are illustrated in figure 6. Very frequently the abdominal spicular zones consist not only of the spicules at the anterior of each segment, but also of a number at the posterior of the preceding segment with which they form a functional group. It must be stressed that in the illustrations of the spicular zones, the thick horizontal lines separate the spicules into these functional groups which often consist of the posterior of one segment and the anterior of the next. From the illustration of the side view of the larva the

position, size and extent of these groups relative to the whole may be seen. The only feature these spicular zones have in common is a tendency to be more numerous on the ventral side of the body, and to tail off rapidly towards the flanks. This is, in part, due to the functions of these zones which, together with a slight protrusion in some species of the intersegmental area to form a pseudopod, aid in locomotion.



FIGS. 4–5.—(4) Generalised anterior spiracle ; (5) generalised posterior spiracle.

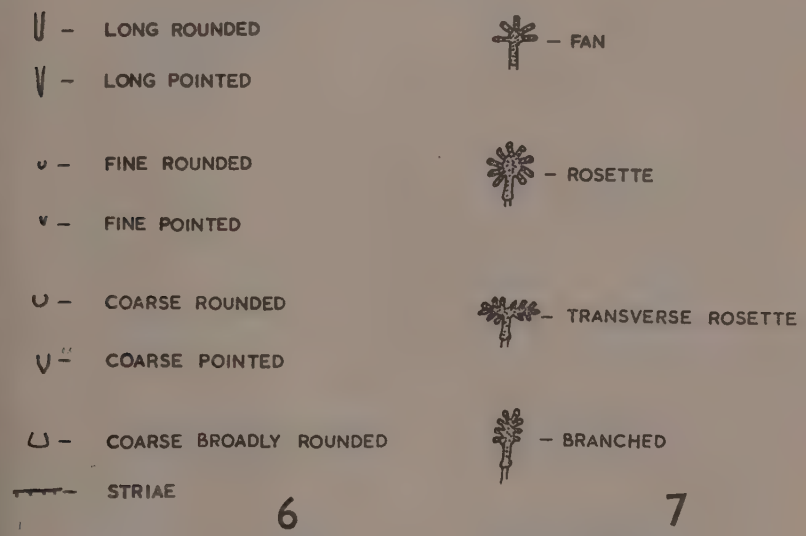
Following the thorax are eight abdominal segments, the terminal or *anal segment* being subdivided by the anus, which is frequently bounded fore and aft by a number of spicules often giving the appearance of a ninth segment. The tracheation and innervation indicate, however, that there are only eight true segments.

The most prominent morphological features of the larva, apart from the cephalo-pharyngeal skeleton, are the *anterior spiracles*. They usually project laterally from the posterior margin of the first thoracic segment, often appearing silvery by reflected light and a pale brown by transmitted light. They consist of a *spiracular trunk*, being the continuation of the main dorsal tracheal trunk, which at this point tends to be bulbous and sometimes bears a small *scar* left by the spiracle of the second instar larva. The trunk then narrows before again enlarging to form a chamber from which the *digitate processes* arise. The arrangement of these processes varies between the genera and may be broadly classified into four intergrading types (fig. 7) :

Fan : 3–7 digitations ; semicircular in shape.
Rosette : 7–12 digitations.
Transverse rosette : 10–15 digitations.
Branched : 9–15 digitations.

The species within a genus have spiracles of the same type but the average number of digitations may differ from species to species. The number of digitations varies to a small extent, within the species, both between individuals and even between their left and right spiracles. From the point where they project from the thorax, the spiracles are loosely covered by a *sheathing membrane* reaching to the end of the digitate process where the chitin is thickened to form a *peritreme* surrounding the *spiracular opening*.

The *posterior spiracles*, often borne on characteristic *spiracular lobes*, commence at the hind end of the main dorsal tracheal trunk and, as in the anterior spiracles, a thickened annular ridge is formed at the junction of the tracheal and spiracular trunk. This latter first widens into a bulb and then narrows until at its distal end it trifurcates and each branch opens to the exterior by a *spiracular opening* surrounded by a *peritreme*. From the cuticle between these peritremes there usually arise in the Acalypterae four groups of *branched hairs* ; these are rudimentary or absent in the Calypterae.



Figs. 6–7.—(6) Types of spicule ; (7) types of anterior spiracle.

IV. General External Morphology of the Second and First Instar Larvae

The second instar larvae are a reduced version of the third. They may be recognised by their respiratory system for, although again amphipneustic, the anterior spiracles are relatively smaller and knob-like with very short digitate processes and cannot be characterised into types. The cephalo-pharyngeal skeleton, though smaller, is similar in form but the sclerites are less heavily tanned than in the corresponding third instar larva. The spicules follow the

same overall pattern as in the third instar but deviate considerably from it in detail.

The first instar larvae are almost transparent and have their characters still further diminished. They are metapneustic and the main dorsal tracheal trunk merely terminates anteriorly in the prothorax as a number of branching tracheoles. The cephalo-pharyngeal skeleton usually differs from that of the second and third instar in having no separate intermediate sclerite but merely a long anterior process to the pharyngeal sclerite which articulates with the mouth-hooks.

V. Key to the Third Instar Larvae

The following key, although broadly based on that of Balachowsky and Mesnil (1935), is very greatly modified. A few of the couplets concern species which it has not been possible to obtain and examine personally, but have been in part described by other authors. They are included so that the key will cover our present knowledge of all the known larvae of the relevant British species.

In using the key no trouble should be experienced in identifying the genera, but specific determinations, especially in the Oscinellinae, sometimes depend on characters in which individual variation tends to overlap into another species. In these cases more than one specimen must be examined to enable the observer himself to judge whether it is typical. The key includes nearly 40 species covering the majority of the larvae, excluding the Agromyzidae, commonly encountered in cereals and pastures.

The term spicular zone is used for functional groups of spicules which, in fact, often consist of the posterior spicules of one segment and the anterior ones of the next.

All the species except *Hydrellia* conform broadly to the general morphology as described in the first section, where the terminology used has been defined. For most of the couplets high power magnification is required.

1 Anterior spiracles absent; posterior spiracular lobes in the form of elongate cones (fig. 44) . . **Hydrellia incana** f. **modesta** Loew (p. 441)
Anterior spiracles present: posterior spiracular lobes not elongate cone shaped 2

2 Anterior spiracles, without distinct digitations, projecting close together dorsally from the prothorax; antennae inconspicuous Agromyzidae
– Anterior spiracles distinctly digitate and projecting laterally from the prothorax; antennae projecting visibly from the head 3

3 Abdominal spicular zones absent 4
– Abdominal spicular zones present and clearly visible 5

4 Apical segment of antenna completely retracted within the basal; prothorax light brownish in colour, with 6 small membranous lobes on its anterior border . . . . . **Lipara lucens** Meigen (p. 445)
– Apical segment of antenna projecting from the basal: prothorax uncoloured and with no lobes on its anterior border . **Calamoncosis minima** Strobl (p. 445)

5 First 3 abdominal spicular zones each consisting ventrally of a series of transverse overlapping rows of fine homogeneous, often slightly

serrate *striae* (fig. 89) [use high power magnification to make sure the rows are not formed of very fine close spicules] ; antennae always directly anterior to the maxillary palps 6

– All abdominal spicular zones each consisting ventrally of a series of transverse rows, which may or may not be regular, of individual or roughly linearly grouped very fine to very coarse *spicules* ; antennae usually, but not always, directly anterior to the maxillary palps . 9

6 Anal segment posteriorly deeply divided into a pair of large spiracular lobes, hence posterior spiracles separated by a deep cleft (fig. 86) : whole larva creamy-white 7

– Anal segment only slightly divided posteriorly ; posterior spiracles closely apposed and not separated by a deep cleft (fig. 80) : whole larva usually a pale green 8

7 Abdominal spicular zones 4–8 with about 3 short rows of linearly grouped fine pointed spicules at anterior, contrasting with the longer lines of striae following them (figs. 88, 89)
Cetema neglecta Tonnoir (p. 468)

– All abdominal spicular zones with lines of striae only, no short anterior rows of spicules . . . . . **Cetema elongata** Meigen (p. 469)

8 Dentate sclerite with tip of each wing tending to point anteriorly (fig. 78) ; anterior spiracle somewhat rosette-shaped with about 9 digitations (fig. 81) . . . . . **Meromyza variegata** Meigen (p. 467)
Meromyza saltatrix L. (p. 468)

– Dentate sclerite with tip of each wing tending to point laterally (fig. 82); anterior spiracle somewhat transverse rosette-shaped with about 11 digitations (fig. 83) . . . . **Meromyza pratorum** Meigen (p. 468)

9 Antennae widely separated, each situated anterolaterally on the head, lateral to the maxillary palps ; maxillary palps completely surrounded by a thick dark brown ring (fig. 90) ; all spicular zones each consisting of over 10 homogeneous rows of very fine spicules . 10

– Antennae each situated directly anterior to the maxillary palps ; maxillary palps consisting of a thin light brown ring or crescent ; abdominal spicular zones each of up to about 10 rows of spicules . 16

10 Posterior spiracular lobes virtually absent ; the spiracles themselves scarcely projecting at all from the almost semicircular anal segment ; an oval flattened larva . . **Anthracophaga strigula** Fabricius (p. 464)

– Anal segment bearing posterior spiracular lobes (though they may be small) from which the spiracles do project (figs. 92, 96) ; a cylindrical or very slightly flattened larva 11

11 Posterior spiracular lobes cup-like and having a dark brown border with 3 or 4 large triangular projections ; basal antennal segment brown . . . . . **Chlorops interrupta** Meigen (p. 476)

– Posterior spiracular lobes unornamented 12

12 Posterior spiracular lobes prominent, each nearly twice as long as broad and separated by a very deep cleft . **Chlorops brevimana** Loew (p. 476)

– Posterior spiracular lobes only about as long as broad and not separated by a very deep cleft (figs. 92, 96) 13

13 Anal segment terminating in a pair of small spiracular lobes separated by at least 3 times their own width ; the cuticle joining the 2 lobes more or less straight and not forming a cleft or " valley " (fig. 92) . 14

— Anal segment terminating in a pair of broadly rounded spiracular lobes separated by a shallow " valley " ; posterior spiracles terminating as small brown knobs facing inwards on the sides of this cleft and not quite terminally (fig. 96) 15

14 Transverse diameter of anus greater than distance between posterior spiracular lobes (fig. 92) . . . **Chlorops pumilionis** Bjerkander (p. 473)
— Transverse diameter of anus less than distance between posterior spiracular lobes . . . . . **Chlorops marchali** Mesnil (p. 476)
15 The area within each maxillary palp ring fairly central and the ring therefore of approximately the same thickness laterally and medially (fig. 94) . . . . . **Chlorops speciosa** Meigen (p. 475)
— The area within each maxillary palp ring distinctly off centre so that the ring is only about half as thick laterally as it is medially **Chlorops** sp. ex *Festuca* (p. 476)
16 Antenna with apical segment almost hemispherical and larger than the ring of the maxillary palp ; genal and frontal rami of facial mask absent 17
— Antenna with apical segment equal to or smaller than the ring of the maxillary palp ; facial mask of genal and frontal rami present . 18
17 Lines of spicules of meso- and metathorax and first abdominal spicular zones disappearing mid-ventrally **Thaumatomyia notata** Zetterstedt (p. 477)
— Lines of spicules of all spicular zones clearly present mid-ventrally **Chloropisca glabra** Meigen (p. 477)
18 Pro-, meso- and metathoracic spicular zones all absent ventrally ; posterior spiracular lobe lightly tanned and terminating in the shape of a three-pointed star ; branched hairs absent **Camarota curvipennis** Latreille (p. 460)
— At least the prothoracic spicular zone ventrally present ; posterior spiracular lobe, if tanned, cylindrical ; branched hairs may or may not be present 19
19 Meso- and metathoracic spicular zones both absent 20
— At least the pro- and mesothoracic spicular zones present 25
20 Posterior spiracular lobes tanned brown (fig. 10) **Palloptera quinquemaculata** Macquart (p. 425)
— Posterior spiracular lobes not tanned 21
21 Facial mask simple, frontal rami between each maxillary and frontal palp absent ; genal rami forming only 3–4 plain cells (fig. 74) **Oscinella trochanterata** Collin (p. 459)
— Facial mask more complex, with about 4 rows of conspicuous, transverse densely spiculate frontal rami between each maxillary and frontal palp ; genal rami forming more than 4 finely spiculate cells 22
22 Anus completely surrounded by well developed spicules **Lasiosina cinctipes** Meigen (p. 462)
— Anal area without or, at the most, with just a few spicules fore and aft 23
23 Second to eighth abdominal spicular zones each of about 8 irregular rows, the spicules of some of the adjacent rows differing in size **Elachiptera cornuta** Fallén (p. 443)
— Second to eighth abdominal spicular zones each of not more than 4 irregular rows, the spicules of some of the adjacent rows differing in size 24
24 Second to eighth abdominal spicular zones with the leading row of spicules continuous mid-ventrally (fig. 54) **Conioscinella frontella** Fallén (p. 445)
— Second to eighth abdominal spicular zones with the leading row of spicules absent mid-ventrally (fig. 50) **Conioscinella mimula** Collin (p. 444)

25 Posterior spiracles borne on lobes which terminate in groups of clearly visible branched hairs (fig. 57) 26
— Posterior spiracles may or may not be borne on lobes ; branched hairs absent but rudimentary unbranched hairs may be present (fig. 100) 38
26 Frontal area of facial mask consisting of numerous contiguous oval cells, some of which may be strongly toothed ; anterior spiracles of rosette or branched type, with 7–14 digitations 27
— Frontal area of facial mask consisting of approximately transverse, often toothed rami, any cells formed being mainly elongate ; anterior spiracles of fan type, with 3–7 digitations 32
27 Anterior spiracles of rosette type ; abdominal spicular zones consisting of irregular rows of linearly grouped spicules ; the zones not divided by a distinct gap into anterior and posterior rows 28
— Anterior spiracles of branched type ; abdominal spicular zones consisting of irregular rows of spicules which may be reduced to rows of scattered spicules ; zones 2–8 divided by a distinct gap into anterior and posterior rows 30
28 Posterior spiracular lobes covered in small light brown warts (fig. 22) **Opomyza petrei** Mesnil (p. 431)
— Posterior spiracular lobes unornamented 29
29 Posterior spiracular lobes distinctly separated by a deep channel (fig. 26) ; 5 or 6 concentric arcs of rounded cells present between the maxillary palp and the inconspicuous frontal palp **Opomyza florum** Fabricius (p. 431)
— Posterior spiracular lobes separated only by a shallow depression (fig. 28) ; 3 concentric arcs of rounded cells present between the maxillary palp and the frontal palp . . . **Opomyza germinationis** L. (p. 435)
30 Anterior of each abdominal spicular zone weakly represented by a few widely spaced, brown spicules (fig. 35) ; frontal cells of facial mask each bearing up to 4 long pointed spicules (fig. 30) **Geomyza combinata** L. (p. 435)
— Anterior of each abdominal spicular zone well represented with 2–3 irregular rows of colourless spicules (fig. 41) ; frontal cells of facial mask without spicules or with only up to 2 per cell 31
31 Frontal cells of facial mask with up to 2 spicules per cell (fig. 36) **Geomyza tripunctata** Fallén (p. 440)
— Frontal cells of facial mask without spicules **Geomyza venusta** Meigen (p. 441)
32 Frontal area of facial mask consisting of numerous approximately transverse arcs each bearing many long membranous teeth (fig. 14) ; abdominal spicular zones present on both dorsal and ventral side of body (fig. 18) . . . . . **Anthomyza sabulosa** Haliday (p. 430)
— Frontal area of facial mask simple and consisting of 3 approximately transverse mid-frontal rami with ends free medially, which may or may not be toothed ; the 4–5 anastomosing genal rami always unornamented ; abdominal spicular zones present only on ventral side of body 33
33 Metathoracic spicular zone absent or represented by not more than a single weak row of grouped fine rounded spicules (figs. 70, 73) . . 34
— Metathoracic spicular zone consisting of 2–3 long irregular rows of fine grouped spicules (figs. 60, 62, 66) 36
34 The 3 pairs of mid-frontal rami on the facial mask strongly toothed (fig. 71) . . . . . **Oscinella albiseta** Meigen (p. 458)
— The 3 pairs of mid-frontal rami entirely plain 35

35 At anterior of each of abdominal spicular zones 2–8 a short mid-ventral row of linearly grouped coarse rounded spicules present, followed by a gap before the principal rows (fig. 70)
Oscinella vastator Curtis (p. 458)

— In abdominal spicular zones no short mid-ventral row of spicules anterior to the principal rows . **Oscinella frit** ex *Anthoxanthum* (p. 454)

36 Spicular zones of second to eighth abdominal segments each consisting of 2–3 long irregular broken rows of homogeneous fine rounded spicules (fig. 60) . . . . . **Oscinella frit** L. (p. 450)

— Spicular zones of second to eighth abdominal segments each consisting of 2–3 long irregular broken rows of spicules, the anterior usually more weakly represented and consisting of rounded individual spicules coarser than the fine rounded spicules of the following row(s) (figs. 62, 66) 37

37 Genal ramus running anteriorly from mouth-opening trifurcates soon and forms 3–4 elongate cells between the genal papilla and the mouth-hook on each side (fig. 55): dorsal and ventral wings of pharyngeal sclerite partially tanned (fig. 56)
Oscinella frit ex *Arrhenatherum* (p. 454)

— Genal ramus running anteriorly from mouth opening bifurcates only at first and forms only 1–2 elongate cells between the genal papilla and the mouth-hook (fig. 63): dorsal and ventral wings not usually tanned (fig. 64) . . . . . **Oscinella nitidissima** Meigen (p. 456)

38 Anterior spiracles of fan or rosette type with up to 12 digitations (fig. 105): abdomen posteriorly distinctly truncated and bearing about 10 membranous lobes around the truncation (fig. 104) 39

— Anterior spiracles of double rosette or double branched type with 14–20 digitations (figs. 101, 109): abdomen posteriorly rounded and not bearing lobes, though papillae may be present (fig. 108) . . . 40

39 The pair of membranous lobes on either side of mid-ventral line bifid (fig. 104): frontal area of mask composed of closed ovoidal cells (fig. 102) . . . . . **Leptohylemyia coarctata** Fallén (p. 481)

— The pair of membranous lobes on either side of mid-ventral line single: frontal area of mask consisting of short transverse arcs bearing very fine spicules . . . . . **Delia cilicrura** Rondani (p. 483)

40 Posterior spiracles borne on lobes projecting posteriorly beyond the abdomen (fig. 100): prothoracic spicular zone consisting of short crescentic groups of spicules (fig. 98) . . . **Amaurosoma** spp. (p. 479)

— Posterior spiracles not projecting on lobes beyond the line of the abdomen (fig. 108): prothoracic spicular zone consisting of closely packed lines of spicules (fig. 106) . . **Phorbia genitalis** Schnabl (p. 483)

VI. External Morphology of the Larvae and Brief Notes on Bionomics

The nomenclature and arrangement of the species follows that of Kloet and Hincks (1945) except where more recent generic revisions are available and cited. In each of the species the general description is given of the larva, viewed with incident light, magnified ten times, and the other descriptions with transmitted light and between 125 and 400 times magnification.

(1) **Pallopteridae**

Palloptera Fallén

(*Sira* Enderlein)

Palloptera quinquemaculata Macquart

(*P. arctuata* Meigen nec Fallén).

Larva partly described and figured by Balachowsky and Mesnil (1935). At Silwood it has been found abundantly, overwintering as a third instar larva, only in the basal tillers of *Arrhenatherum elatius* L. Pupation occurs towards the end of April and emergence towards the end of May.

Third Instar Larva (figs. 8–13)

General description.—Creamy-yellow typically acalypterate larva, up to 7 mm. long and 1·2 mm. in diameter. No cephalic features visible except for a small dentate sclerite and the cephalo-pharyngeal skeleton, heavily tanned throughout. No thoracic or abdominal spicules visible. Anterior spiracles of the small fan type. Larva characterised by a very broadly rounded, almost semicircular anal segment having dark brown posterior spiracular lobes.

Facial mask (fig. 8).—Antennae set close together, each consisting of a large cylindrical basal segment surmounted by a smaller lightly tanned ovoidal segment. Maxillary palps of the open type and lightly tanned. Frontal palps forming 2 of the few cells of the mask and bounded by a number of frontal and lateral rami, all of which are quite unornamented. Three genal rami arise from each side of the mouth opening, bifurcating and anastomosing to form a simple mask.

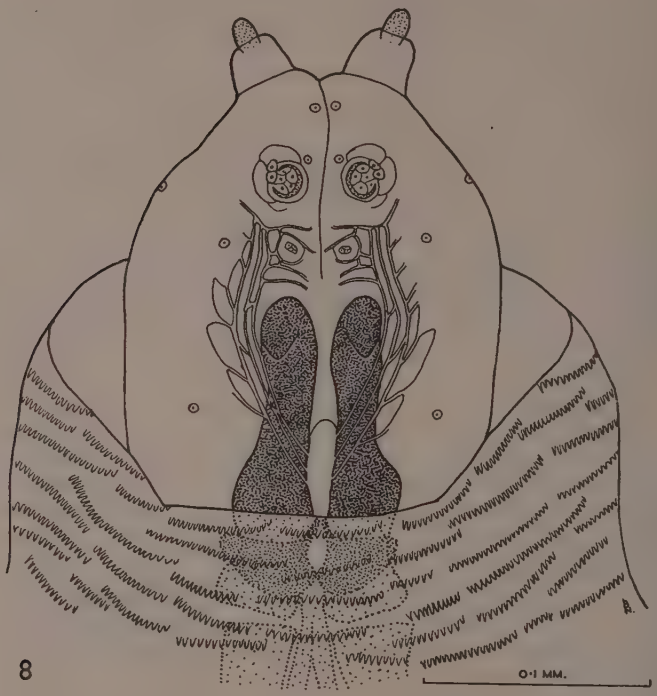
Cephalo-pharyngeal skeleton (fig. 9).—Mouth-hooks robust; apical tooth followed by about 5 smaller denticles. Ventral to the mouth-hooks the dentate sclerite medially just divided and showing an intermediate condition between those species having a pair of separated sclerites and those having a single median sclerite. Intermediate sclerite short and posteriorly fused to pharyngeal sclerite, which has a large ventral wing process. The whole skeleton except for posterior of dorsal and ventral wing heavily tanned. In ventral view the liguloid plates appear as prominent rods just anterior to the hypostomal arch.

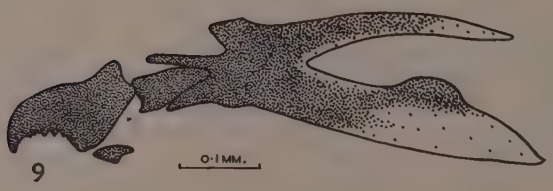
Anterior spiracles (fig. 11) of the fan type and pale brown by transmitted light. Of the spiracles examined 71 per cent. had 5 and 29 per cent. had 6 digitations.

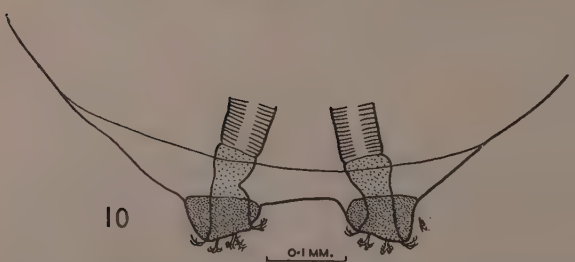
Posterior spiracles (fig. 10) each borne on distinctly tanned spiracular lobes. Spiracular trunk short and broad, terminating in 4 tufts of branched hairs.

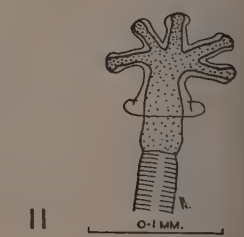
Spicular zones (figs. 12, 13).—Ventral distribution:

Zone I:	5–8 irregular broken rows of linear groups of narrow pointed spicules.
Zone II:	absent.
Zone III:	absent.
Zone 1:	approximately 5 irregular broken rows of short linear groups of broad rounded spicules.
Zones 2–6:	2–3 irregular broken rows of linear groups of broad rounded spicules.
Zones 7–8:	1–2 irregular broken rows of linear groups of broad rounded spicules.
Anal zone:	1–2 groups of broad pointed spicules just anterior to the anus.

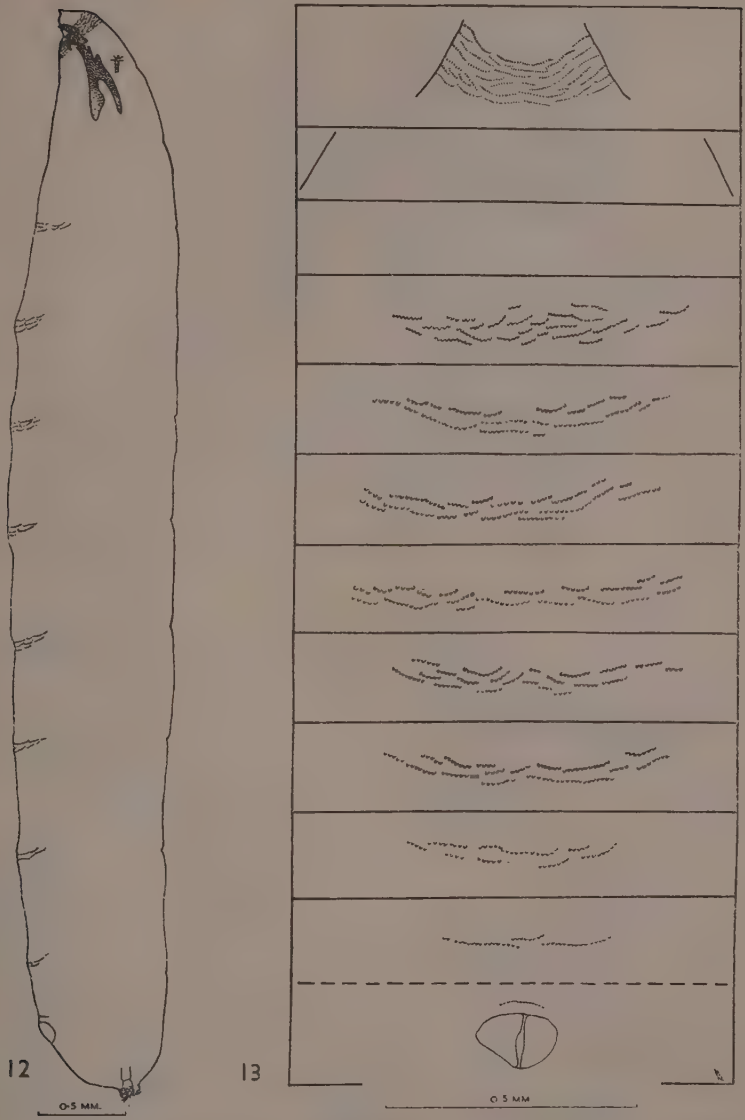




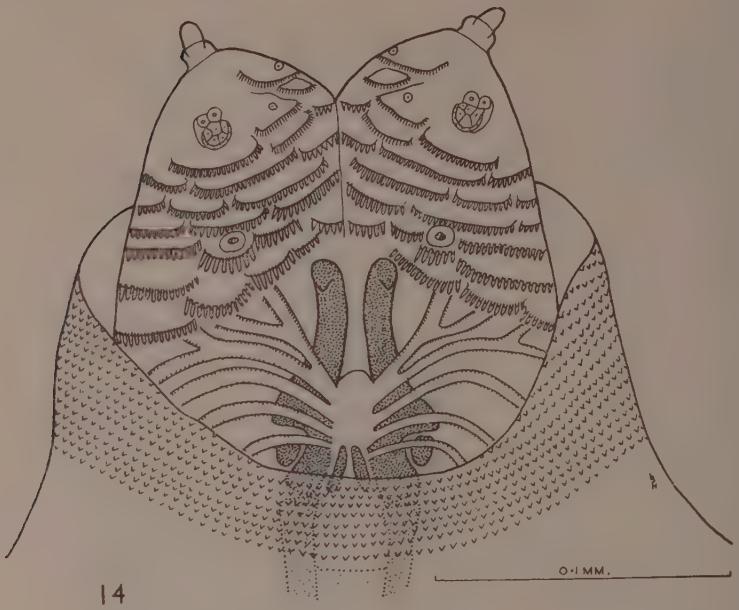




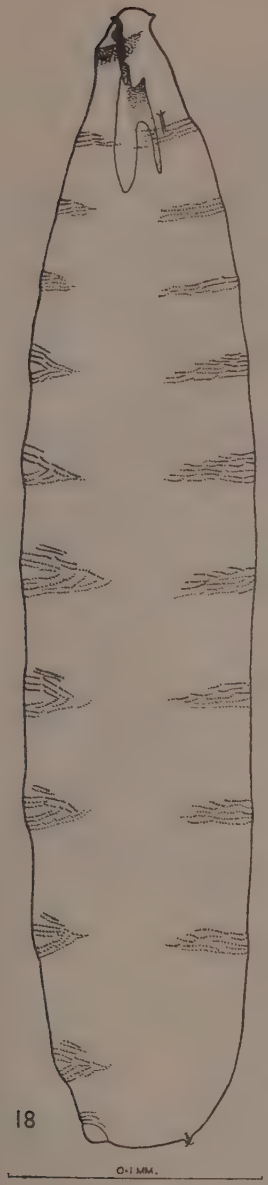
FIGS. 8–11.—*Palloptera quinquemaculata* Macquart: (8) facial mask; (9) cephalopharyngeal skeleton; (10) posterior spiracles; (11) anterior spiracles.

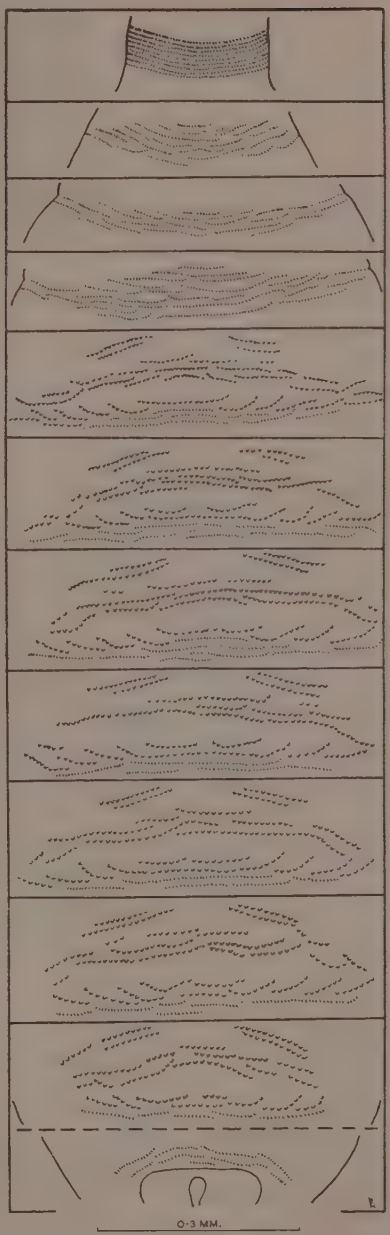


FIGS. 12–13.—*P. quinquemaculata :* spicular zones.



FIGS. 14–17.—*Anthomyza sabulosa* Haliday: (14) facial mask; (15) cephalo-pharyngeal skeleton (16) posterior spiracles; (17) anterior spiracles.





FIGS. 18–19.—*A. sabulosa :* spicular zones.

(2) **Anthomyzidae**

Anthomyza Fallén

(*Stiphrosoma* Czerny)

(*Ptenotaenia* Enderlein)

Anthomyza sabulosa Haliday

Larva partly described and figured by Thomas (1932). Overwintering takes place as a third instar larva which has been found at Silwood Park in *Arrhenatherum elatius* L. and in *Lolium perenne* L. Pupation occurs towards the end of April and emergence towards the end of May. Third instar larvae have been found in July so it is likely that there are at least two generations per year. The larvae generally feed between the leaf sheaths of tillers but do not sever the central shoot and hence cause little damage.

Third Instar Larva (figs. 14–19)

General description.—A small extremely active, typically acalypterate larva, up to 4 mm. long and 0·5 mm. in diameter. Thoracic area almost transparent and followed by a yellow anterior half of the abdomen and a white posterior half. Cephalo-pharyngeal skeleton tanned anteriorly and characteristically shaped.

Facial mask (fig. 14).—Head anteriorly divided by a deep median groove into halves each surmounted by an uncoloured 2-segmented antenna. Maxillary palps also uncoloured and of the open type. Frontal palps surrounded in frontal and lateral areas by many ctenoid groups of long rounded denticles. Four or 5 very broad slightly serrate genal rami arise from each side of mouth opening ; the anterior pairs bifurcating and running anteriorly to the groups of denticles.

Cephalo-pharyngeal skeleton (fig. 15).—Mouth-hooks slender, sickle-shaped and the fine apical tooth followed by a series of small denticles. Paired dentate sclerites present. Intermediate sclerite long and slender ; pharyngeal sclerite more robust, the ventral wing being particularly large. Whole skeleton relatively lightly tanned, even the mouth-hooks being dark brown rather than the usual black of other species.

Anterior spiracles (fig. 17) small, and of the fan type. Of the spiracles examined 20 per cent. had 3 digitations, 60 per cent. had 4 and 20 per cent. had 5.

Posterior spiracles (fig. 16) borne on small widely-spaced spiracular lobes. Spiracular trunk slender and terminating in 4 groups of fine branched hairs. Anus at posterior of anal segment (fig. 18).

Spicular zones (figs. 18, 19): Ventral distribution :

Zone I :		9–12 fairly regular rows of faint individual coarse pointed spicules.
Zone II :		4–6 irregular broken rows of linearly grouped fine pointed spicules.
Zone III :		3–5 irregular broken rows as preceding.
Zone I :		6–9 irregular broken rows as preceding.
Zones 2–8	Anterior :	2 short rows on either side of mid-ventral line of coarse rounded spicules followed by 3 irregular broken rows of linearly grouped coarse rounded spicules.
	Posterior :	3–4 irregular broken rows of linearly grouped spicules, the anterior rows of coarse rounded spicules becoming fine rounded spicules in the posterior rows.
Anal zone :		2–3 irregular broken short rows of linearly grouped fine pointed spicules around anterior of anus.

(3) **Opomyzidae**

Opomyza Fallén

Collin (1945) has been followed in the classification of this genus. Larvae of three of the six British species have been bred out.

Opomyza petrei Mesnil

Larva first described and figured by Mesnil (1934) and Balachowsky and Mesnil (1935). It has been found at Silwood Park overwintering in the basal tillers of *Holcus lanatus* L. and *Anthoxanthum odoratum* L. Pupation occurs in early May and emergence in early June.

Third Instar Larva (figs. 20–25)

General description.—Creamy-yellow typically acalypterate larva, up to 8 mm. long and 1 mm. in diameter. A prominent dark dentate sclerite present and the cephalopharyngeal skeleton densely sclerotised throughout, but no other cephalic features visible. Anterior spiracles of the rosette type. Posterior spiracular lobes distinctly separate and characteristically covered with small, lightly tanned warts.

Facial mask (fig. 20).—Apical segment of the small antenna lightly tanned. Maxillary palp of the closed type, lightly tanned. Between maxillary palp and the inconspicuous frontal palp are 5 concentric arcs each composed of 4–6 rounded cells, about half of which bear a long pointed spicule, these areas of rounded cells being continued laterally and posteriorly to the frontal palp, most of the cells then bearing at least one long pointed spicule. In the genal area 3 genal rami running from each side of mouth opening bifurcate and anastomose to form plain elongate cells linking with the rounded cells on a level with apical tooth of mouth-hooks.

Cephalo-pharyngeal skeleton (fig. 21).—Mouth-hooks robust and apical tooth followed by 3 or 4 smaller teeth. A single large crescentic dentate sclerite present. Intermediate sclerites short and joined by a prominent hypostomal bridge anterior to which the liguloid plates are elongate and plainly visible. Intermediate sclerites fused with pharyngeal sclerite. Whole skeleton (except for tip of the ventral wing densely tanned throughout.

Anterior spiracles (fig. 23) of the rosette type with small spiracular fissures. Of the spiracles examined 11 per cent. had 8 digitations, 50 per cent. had 9, 35 per cent. had 10 and 4 per cent. had 11.

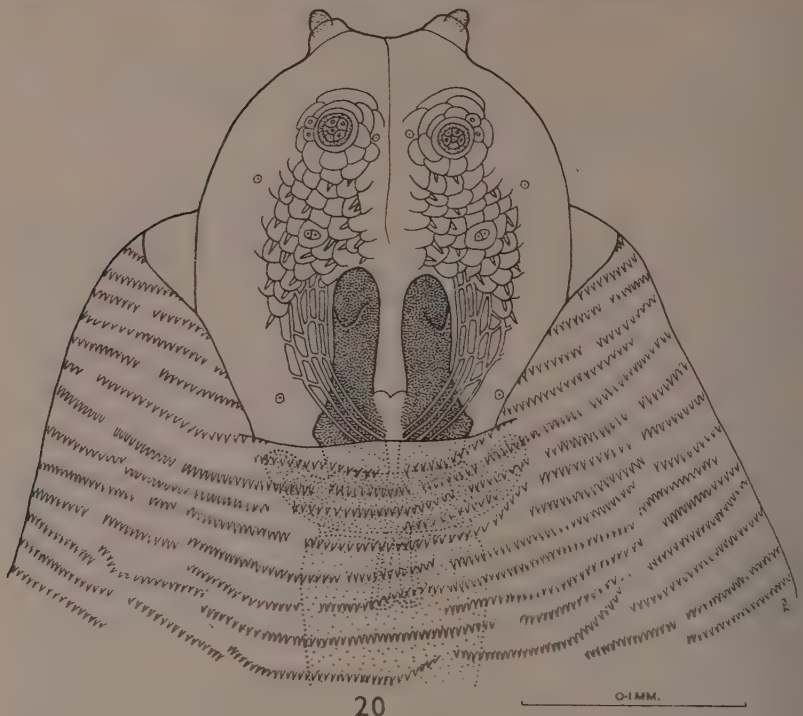
Posterior spiracles (fig. 22) each borne on large distinctly separate spiracular lobes, posteriorly covered in light brown circular warts; the lobes close, detritus accumulating between them. Four groups of fine branched hairs present.

Spicular zones (figs. 24, 25).—Ventral distribution:

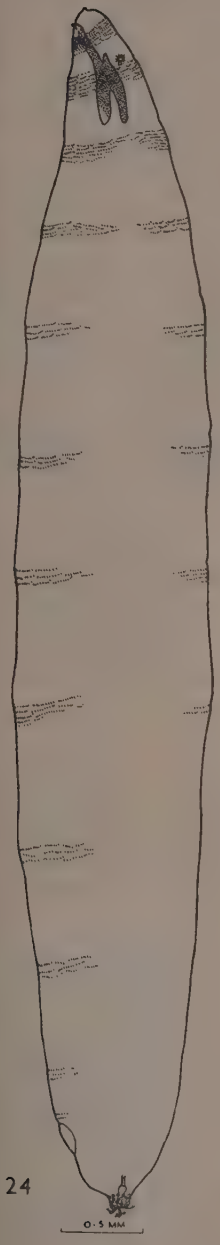
Zone I:	9–12 irregular broken rows of linearly grouped long pointed spicules.
Zone II:	9–12 irregular broken rows of shorter linear groups of fine pointed spicules.
Zone III:	3–5 irregular broken rows of short linear groups of fine pointed spicules.
Zones 1–8:	2–4 irregular broken rows as preceding.
Anal zone:	2 short rows of linearly grouped fine pointed spicules anterior to anus.

Opomyza florum Fabricius

This species can be a serious pest of cereals, especially winter wheat, and has accordingly received considerable attention. The larva has, to a greater or lesser extent, been described and figured by Bielsky (1917), Czerny (1928),



FIGS. 20–23.—*Opomyza petrei* Mesnil : (20) facial mask ; (21) cephalo-pharyngeal skeleton ; (22) posterior spiracles ; (23) anterior spiracles.



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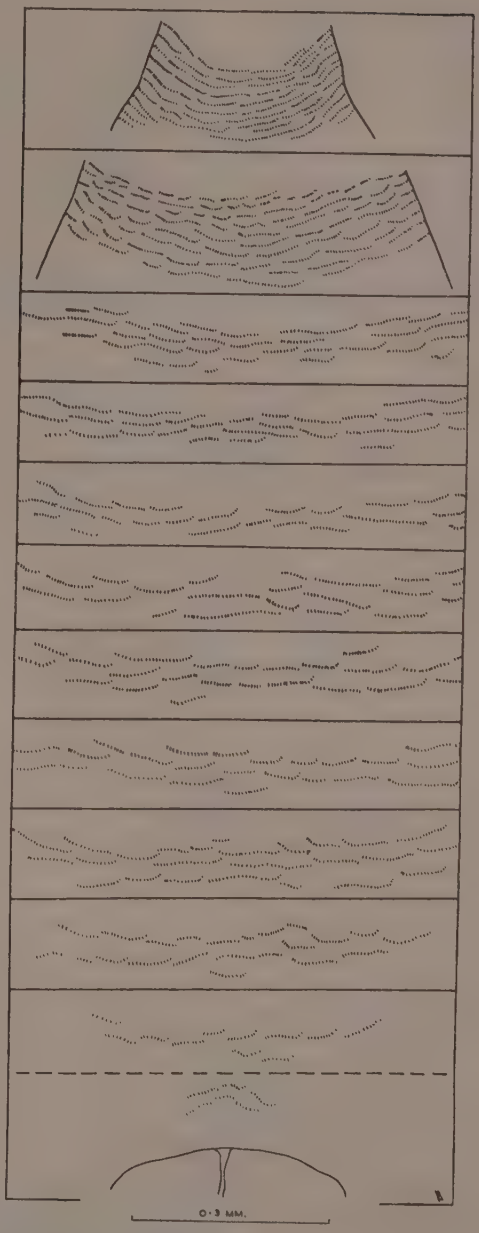

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FIGS. 24–25.—*O. petrei* : spicular zones.

Kreuter (1928), Thomas (1933), Mesnil (1934), Balachowsky and Mesnil (1935) and Oettingen (1935).

The life history is unusual as it is the only Acalypterate species considered here that overwinters as an egg. These hatch at the end of March and bore into wheat tillers near which they have been laid. Pupation occurs during May and the adult emerges in the first half of June. They live throughout the summer and do not oviposit until October and early November, when the eggs are laid on the soil close to young winter wheat. The wild hosts are not known.

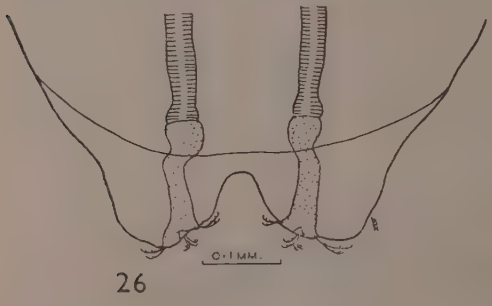
Third Instar Larva (figs. 26, 27)

General description.—As for *O. petrei* except that dentate sclerite even more prominent and posterior spiracular lobes, although distinctly separate, plain and not covered with warts.

Facial mask very similar to that of *O. petrei* except that instead of posterior edges of rounded cells between maxillary palp and frontal palp bearing long relatively narrow spicules, they bear 1 or 2 short very broad teeth.

Cephalo-pharyngeal skeleton.—As for *O. petrei.*

Anterior spiracles (fig. 27) of the rosette type and similar to those of *O. petrei* but central area of spiracular trunk from which digitations arise relatively larger and the latter accordingly more spaced out. Of the spiracles examined 3 per cent. had 8 digitations, 30 per cent. had 9, 54 per cent. had 10 and 13 per cent. had 11.



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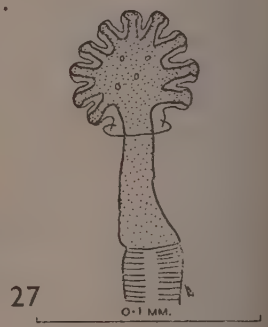

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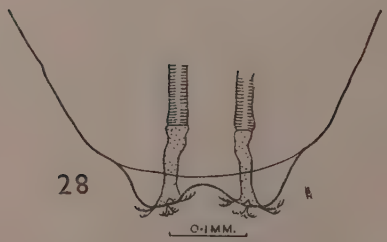

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FIGS. 26–27.—*Opomyza florum* Fabricius : (26) posterior spiracles ; (27) anterior spiracles.

FIGS. 28–29.—*Opomyza germinationis* L. : (28) posterior spiracles ; (29) anterior spiracles.

Posterior spiracles (fig. 26) each borne on plain spiracular lobes, well separated by a deep channel. Branched hairs present.

Spicular zones.—Distribution as for *O. petrei* but the short linear groups of the thoracic zones more regular and tending to turn up at each end, nearly joining the groups of the preceding row, giving almost a mesh-like appearance.

Opomyza germinationis Linnaeus

Larva partly described and figured by Thomas (1934), Mesnil (1934) and Balachowsky and Mesnil (1935). Overwintering takes place as a third instar larva in the basal tillers of *Festuca pratensis* Huds., *F. rubra* L., *Lolium perenne* L., *Poa annua* L., *P. pratensis* L., *P. trivialis* L., *Agrostis tenuis* Sibth., *A. stolonifera* L., *Phleum pratense* L., *Alopecurus pratensis* L., *Phalaris tuberosa* L. and, to a lesser extent, in *Holcus lanatus* L. Pupation occurs in early May and emergence in early June.

Third Instar Larva (figs. 28, 29)

General description.—As for *O. petrei* except that posterior spiracular lobes plain, without warts and not distinctly separate.

Facial mask very similar to that of *O. petrei* except that between maxillary palp and inconspicuous frontal palp only 2 or 3 concentric arcs are present, each composed of 4–6 rounded cells.

Cephalo-pharyngeal skeleton.—As for *O. petrei*.

Anterior spiracles (fig. 29) of the rosette type and similar to those of *O. petrei* but the digitations longer and central area of spiracular trunk from which they arise smaller. Of the spiracles examined 5 per cent. had 6 digitations, 30 per cent. had 7, 35 per cent. had 8 and 30 per cent. had 9.

Posterior spiracles (fig. 28) borne on plain untanned spiracular lobes having only a shallow depression between them. Four groups of fine branched hairs present.

Spicular zones.—As for *O. petrei*.

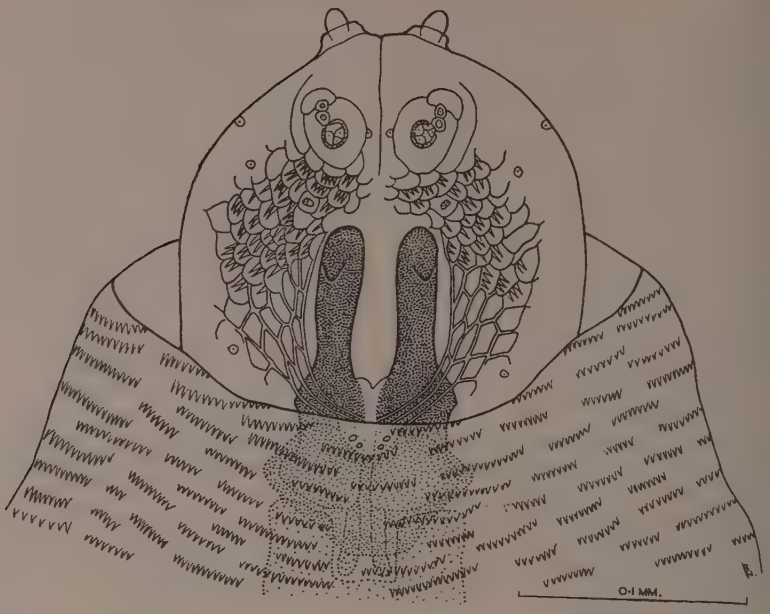
Geomyza Fallén
(*Balioptera* Loew)

Collin (1945) has been followed in the classification of this genus. Seven British species are listed of which two have been bred out. A few notes on *G. venusta* Meig. are included, since it has been partly described by Mesnil (1934) and is on the British list, although Collin (1945) has not seen a British specimen of this species.

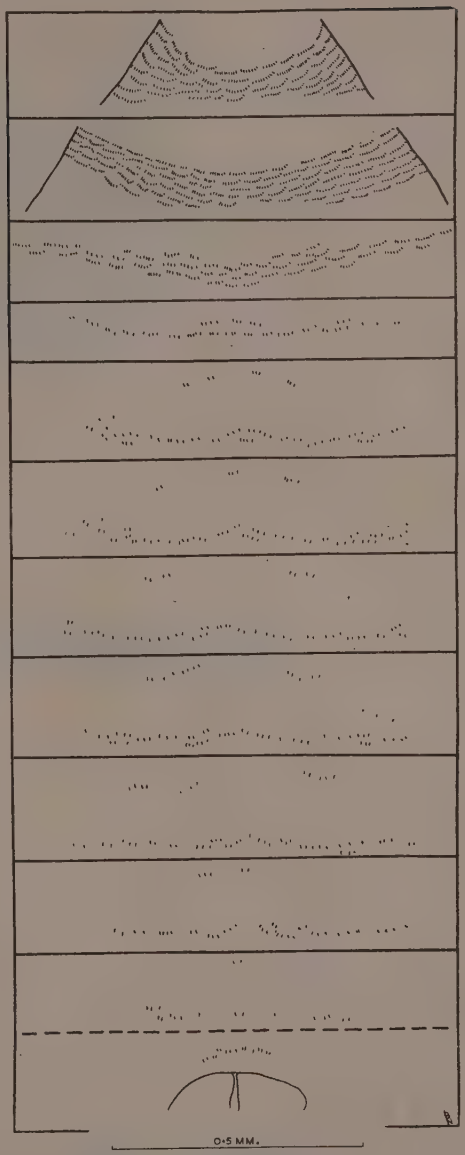
Geomyza combinata Linnaeus
(*G. balachowskyi* Mesnil.)

The larva of this species was first figured and described in considerable detail by Frew (1923). According to Collin (1945), Mesnil (1934) has in error described the imago as a new species *G. balachowskyi*, and included a short larval description and a figure of part of the facial mask: to add to the confusion Mesnil used the name *combinata* for an apparently new species (not yet on the British list) which is very close to our *G. tripunctata*. In Balachowsky and Mesnil (1935) some further larval figures are added but the errors in nomenclature are repeated.

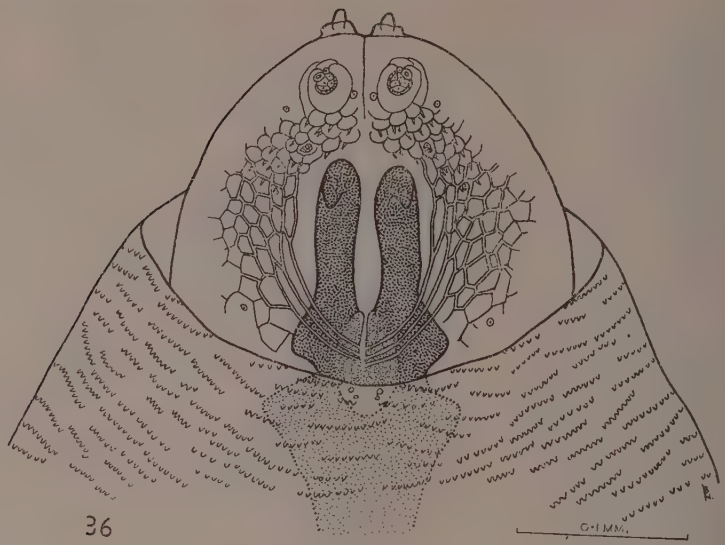
The larvae overwinter in the basal tillers of *Holcus lanatus* L. and *H. mollis* L. They pupate in April and emerge in early May. There is almost certainly a summer generation emerging in July which gives rise to the overwintering larvae, but this has not definitely been established.

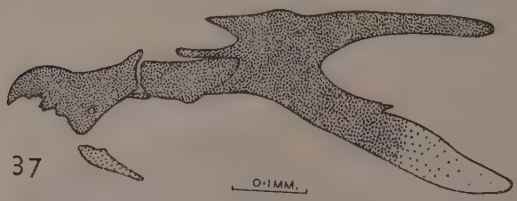


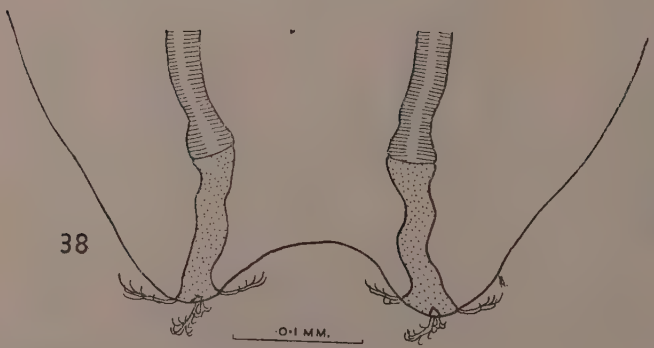
FIGS. 30–33.—*Geomyza combinata* L. : (30) facial mask ; (31) cephalo-pharyngeal skeleton ; (32) posterior spiracles ; (33) anterior spiracles.



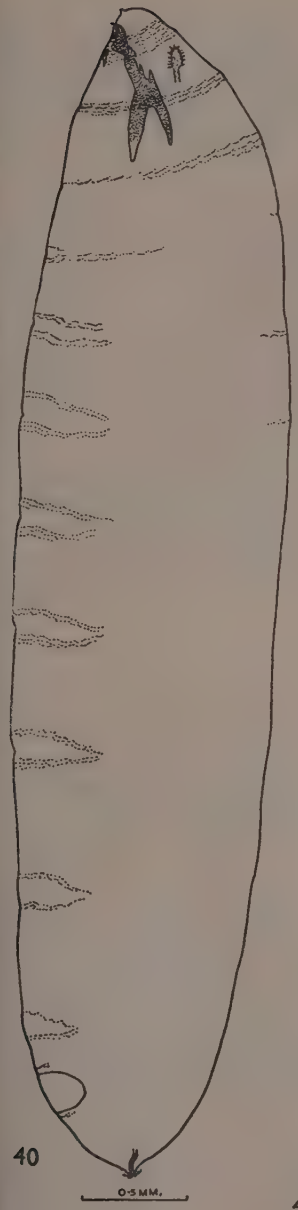
FIGS. 34–35.—*G. combinata :* spicular zones.
(Fig. 34 shows larva containing *Mermis* sp.)

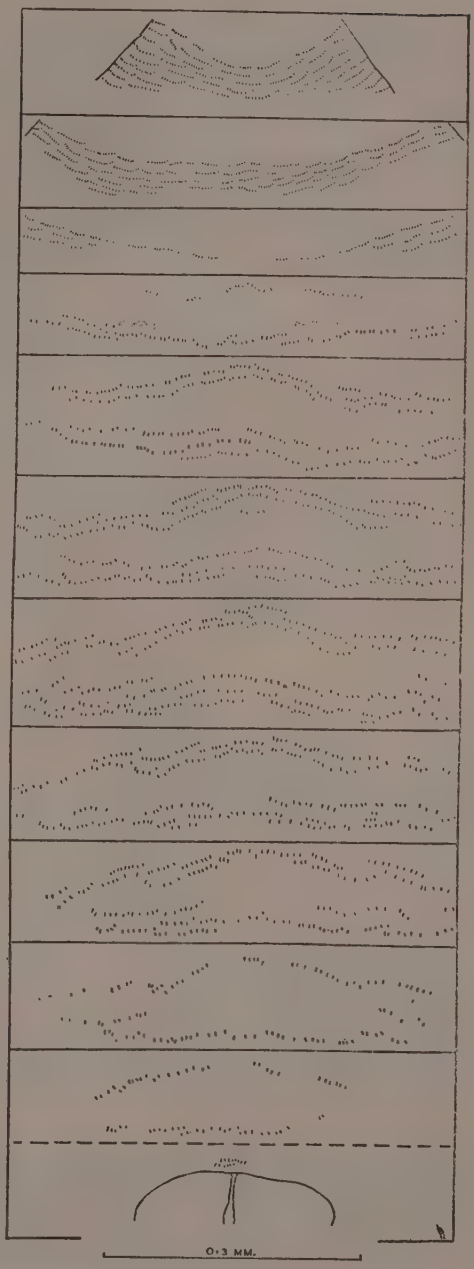






Figs. 36–39.—*Geomyza tripunctata* Fallén: (36) facial mask; (37) cephalo-pharyngeal skeleton; (38) posterior spiracles; (39) anterior spiracles.





FIGS. 40–41.—*G. tripunctata :* spicular zones.

Third Instar Larva (figs. 30–35)

General description.—Creamy-white typically acalypterate larva, up to 5·5 mm. long and 1·0 mm. diameter ; these dimensions giving a relatively stocky appearance, accentuated by the head being normally partially retracted and bent ventrally, which posture throws forward the prominent and branching anterior spiracles. No facial features visible apart from a densely sclerotised cephalo-pharyngeal skeleton including a prominent dentate sclerite. No thoracic or abdominal spicules can be seen. Posterior spiracular lobes distinctly separated by a deep groove and faintly tanned.

Facial mask (fig. 30).—Antennae small and uncoloured. Maxillary palps of the open type, very lightly tanned, and surrounded by an area comparatively free of cells. Between the maxillary, and the inconspicuous frontal palp 2 concentric arcs present, each composed of 3–5 rounded cells, each bearing up to 4 long pointed spicules ; these series of rounded cells and spicules continuing laterally and posteriorly to the genal area, there forming more elongate plain cells which anastomose into 3 genal rami. Labial plate and labial pores plainly visible immediately anterior to dentate sclerite.

Cephalo-pharyngeal skeleton (fig. 31).—Mouth-hooks robust and apical tooth followed by 4 or 5 smaller teeth. A single large V-shaped dentate sclerite present. Intermediate sclerites short and joined by a prominent hypostomal bridge anterior to which the liguloid plates are elongate and plainly visible. Intermediate sclerites fused with pharyngeal sclerite. Whole skeleton (except for the tip of the ventral wing) densely tanned throughout.

Anterior spiracles (fig. 33) of the branched type with small spiracular fissures. Of the spiracles examined 1 per cent. had 8 digitations, 7 per cent. had 9, 31 per cent. had 10, 38 per cent. had 11, 21 per cent. had 12 and 2 per cent. had 13.

Posterior spiracles (fig. 32) borne on large spiracular lobes, distinctly separated by a deep groove and terminating in 4 groups of fine branched hairs.

Spicular zones (figs. 34, 35).—Ventral distribution :

Zone I :		6–9 irregular broken rows of short linear groups of long pointed spicules.
Zone II :		6–9 irregular broken rows as preceding.
Zone III :		3–4 irregular broken rows of short linear groups of fine pointed spicules.
Zone 1 :		2 irregular rows of widely spaced fine rounded spicules.
Zones 2–8	Anterior :	1 irregular row of very widely spaced fine rounded spicules.
	Posterior :	1–2 irregular rows of widely spaced fine rounded spicules.
Anal zone :		1–2 linear groups of fine pointed spicules just fore and aft of anus.

Geomyza tripunctata Fallén

Larva partly described and figured by Kreuter (1928), Mesnil (1934) and Balachowsky and Mesnil (1935). Thomas (1938) described and illustrated all the immature stages and dealt with the bionomics of this species.

G. tripunctata overwinters as larvae in the basal tillers of *Lolium multiflorum* Lam., and to a lesser extent in *L. perenne* L. They pupate in March, emerge in April and oviposit in early May. This second generation emerges in July and oviposits in August, giving rise to the overwintering larvae.

Third Instar Larva (figs. 36–41)

General description.—As for *G. combinata* except that abdominal spicules can be clearly seen as about 5 lines in each spicular zone.

Facial mask (fig. 36) very similar to that of *G. combinata* except that the rounded cells each bear only up to 2 long pointed spicules and do not continue so far posteriorly into the genal area.

Cephalo-pharyngeal skeleton (fig. 37) very similar to that of *G. combinata*.

Anterior spiracles (fig. 39) of the branched type and on average with more digitations than *G. combinata*. Of the spiracles examined 5 per cent. had 11 digitations, 10 per cent. had 12, 40 per cent. had 13, 4 per cent. had 14, and 5 per cent. had 16.

Posterior spiracles (fig. 38) borne on large spiracular lobes, separated only by a shallow depression. The 4 groups of branched hairs present.

Spicular zones (figs. 40–41).—Ventral distribution :

Zone I :		6–9 irregular broken rows of short linear groups of coarse pointed spicules.
Zone II :		5–8 irregular broken rows as preceding.
Zone III :		1–4 irregular broken rows as preceding, the lines disappearing towards the mid-ventral line.
Zone 1	Anterior :	1 irregular row of widely spaced coarse, rounded dark brown spicules.
	Posterior :	2 irregular rows as preceding.
Zones 2–8	Anterior :	2–3 irregular rows as preceding.
	Posterior :	2–3 irregular rows as preceding.
Anal zone :		1–2 groups of fine pointed spicules fore and aft of anus.

Geomyza venusta Meigen

The larva of this species has been briefly described and in part figured by Mesnil (1934) and Balachowsky and Mesnil (1935), who record that it overwinters in the basal tillers of *Bromus* sp., and that the adults appear in May. According to Mesnil its facial mask is similar to that of *G. combinata* but none of the cells bear spicules.

(4) Ephydridae

Hydrellia Robineau-Desvoidy

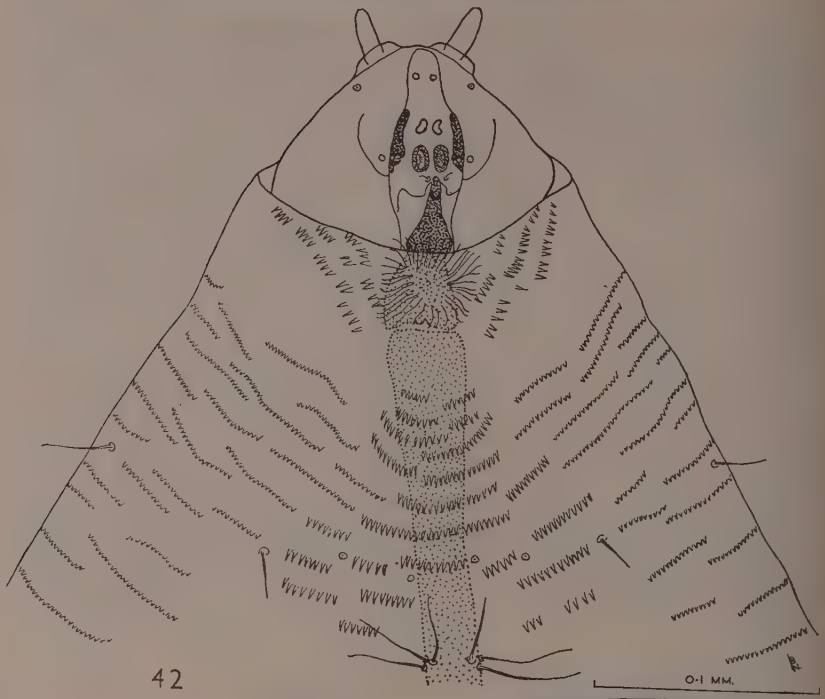
(*Hydropota* Rondani)

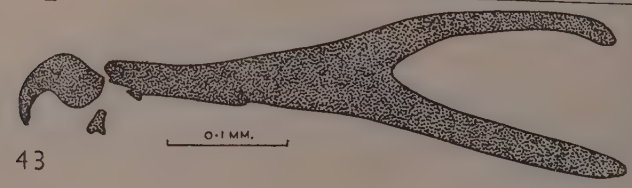
Hydrellia incana f. *modesta* Loew

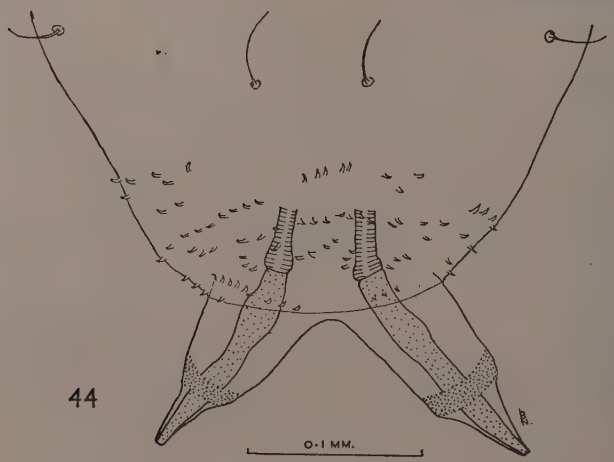
This species was identified by the late Dr. F. I. van Emden who considered that Séguy's *H. obscura* Meig., 1830 is the same species as *griseola* Fln., 1813, as Séguy himself states on the basis of Meigen's types (Séguy, 1934 : 431), but the latter also has a *griseola* Fln. on page 430. According to the British Museum collection this is precisely *incana* f. *modesta* Loew. In the work of Schiner (1862–64) from which many older identifications were made, *incana* f. *modesta* will also be traced to *griseola*. The identifications in the older literature are bound to be more or less unreliable, and the records of host plants based on them must therefore be treated with reserve.

No description of the larva of *H. incana* f. *modesta* exists, but that of "*H. griseola*" has been very briefly given by Stein (1867), Müller (1922), Kreuter (1927, 1928), Balachowsky and Mesnil (1935) and Oettingen (1935), and as shown in the preceding paragraph some or all of these may refer to what is here called *modesta*. In no case is there sufficient detail to enable any comparison of the larvae.

In both species the larva mines and overwinters in the basal part of the leaf blade and leaf sheath but does not penetrate to the central shoot. Pupation occurs at the end of March and the adults emerge in May. There are two summer generations. *H. incana* f. *modesta* has been found in *Holcus lanatus* L., *H. mollis* L. and *Anthoxanthum odoratum* L., but not yet in any cereals at Silwood Park, although growing adjacent to the wild host grasses.







FIGS. 42–44.—*Hydrellia incana* f. *modesta* Loew.: (42) facial mask; (43) cephalo-pharyngeal skeleton; (44) posterior spiracles.

Third Instar Larva (figs 42–44)

General description.—A non-typical acalypterate larva, up to 6 mm. long and 0·7 mm. diameter. Anterior half yellow; posterior, which is not rounded but tapers to a pair of pointed posterior spiracles, white. Anterior spiracles absent. Cephalo-pharyngeal skeleton heavily tanned throughout and laterally compressed. A small dentate sclerite visible but no other cephalic features. Abdomen cylindrical encircled by indistinct pale spicular zone.

Facial mask (fig. 42) surmounted by antennae with a very elongate apical segment. Between the antennae is a raised portion of the face along the mid-ventral line bearing first the anterior cephalic papillae, then a pair of larger frontal papillae and then prominent maxillary palps of the closed type. Immediately laterally to these are the frontal palps consisting of about 3 papillae, flanked by a pair of anterior and posterior sclerites. Posterior to each maxillary palp is a single seta borne on the labral lobe. A single mouth-hook only present, behind which the mouth opening is surrounded by a clump of numerous hairs.

Cephalo-pharyngeal skeleton (fig. 43) extremely laterally compressed and having only a single mouth-hook with a slender apical tooth followed by minute serrations. Ventral to the mouth-hook is a small dentate sclerite. Only a single intermediate sclerite and this completely fused into pharyngeal sclerite, which is anteriorly single but bifurcates to form paired slender dorsal and ventral wings.

Anterior spiracles.—In common with the other known larvae of this genus, no anterior spiracles present.

Posterior spiracles (fig. 44) borne on long tapering spiracular lobes each girdled at approximately a third of the way by a band of tanned cuticle; not terminating in branched hairs.

Spicular zones'—Ventral distribution:

Zone I:	at anterior of prothorax, just behind clump of hairs surrounding mouth opening, about 4 rows of linear groups of long pointed spicules; then medially after a short gap a further series of about 8 short rows of linearly grouped long pointed spicules, the rows continued laterally as fine pointed spicules.
Zone II:	about 12 irregular broken rows of linearly grouped fine pointed spicules; the spicules becoming medially of the long pointed type but not forming a distinctly separate area.
Zone III:	medially about 10 irregular broken rows of linearly grouped fine pointed spicules merging laterally into more scattered coarser pointed spicules.
Zones 1–8:	medially about 10 short rows of long pointed spicules forming a distinct area, which merges laterally into more scattered coarser pointed spicules; these lateral spicules successively reduced in number in each zone until in Zone 8 they are entirely absent.
Anal zone:	a few fine pointed spicules fore and aft of anus.

(5) Chloropidae

Elachiptera Macquart

Elachiptera cornuta Fallén

Larva partly described and figured by Vimmer (1926 and 1931), Kreuter (1928) and Balachowsky and Mesnil (1935). According to the latter this species is saprophagous and overwinters, either as larvae in decaying leaves or as adults between the sheaths of *Typha* spp. in damp localities. Pupation

occurs in April and the adults emerge in early May. It is reported that eggs are laid on spring cereals which have already been attacked by *Oscinella frit* L., but I have not found this to be the case at Silwood Park and have not yet been able to obtain any larvae.

No adequate description or illustration available. Larvae apparently similar to *Conioscinella mimula* in general appearance and facial mask. Well developed prothoracic spicules present, but meso- and metathoracic zones absent. The one abdominal spicular zone illustrated by Balachowsky and Mesnil (1935) consists of about 8 irregular rows, spicules of some of adjacent rows differing in type.

Conioscinella Duda

Conioscinella mimula Collin

The larva of this species has not previously been recorded. It overwinters in the basal tillers of *Anthoxanthum odoratum* L., pupates in April and emerges in May.

Third Instar Larva (figs. 45–50)

General description.—Creamy-white, very active, typically acalypterate larva, up to approximately 4·5 mm. long and 0·6 mm. diameter. No dentate sclerite or other facial features visible. Mouth-hooks black in lateral view but colour rapidly fades further back in cephalo-pharyngeal skeleton. Anterior spiracles of the fan type and inconspicuous.

Facial mask (fig. 45).—Head anteriorly divided by a median groove into halves, each surmounted by a large, two-segmented antenna borne on a prominent boss, tending to give the appearance of a further segment. Maxillary palps untanned and of the open type. Two transverse frontal rami to anterior and 2 to posterior of frontal palp together with 3 mid-frontal rami; all rami very strongly spiculate. Arising from each side of mouth opening are 3 genal rami running anterolaterally, bifurcating and anastomosing to form elongate cells each bounded along anterior edge by fine spicules. Dentate sclerites not visible.

Cephalo-pharyngeal skeleton (fig. 46).—Apical tooth of the robust mouth-hooks followed by a series of fine serrations. A small dentate sclerite ventral to each mouth-hook. Intermediate sclerites heavily tanned anteriorly but not posteriorly, and joined ventrally by a pale hypostomal bridge anterior to which are small hypostomal plates. Pharyngeal sclerite only very lightly tanned, the ventral wing being almost colourless.

Anterior spiracles (fig. 48) small and of the fan type. Of those examined 75 per cent. had 4 digitations and 25 per cent. had 5.

Posterior spiracles (fig. 47) borne on small widely spaced spiracular lobes. The 4 tufts of branched hairs present.

Spicular zones (figs. 49, 50).—Ventral distribution:

Zone I:		6–9 irregular broken rows of short linear groups of fine pointed spicules.
Zone II:		absent.
Zone III:		absent.
Zone 1	Anterior:	2–3 irregular broken rows of approximately linearly grouped coarse to very coarse rounded spicules.
	Posterior:	2 irregular broken rows of linearly grouped fine to coarse rounded spicules.
Zones 2–8	Anterior:	1 row, absent mid-ventrally, of a few very coarse rounded spicules.
	Posterior:	1 broken irregular row of spaced, very coarse rounded spicules.
		1 broken irregular row of fine rounded spicules.

Conioscinella frontella Fallén

(*C. pratensis* Meigen).

The larva of this species has not previously been recorded. It overwinters in the basal tillers of *Holcus lanatus* L., pupates in April and emerges in May.

Third Instar Larva (figs. 51–54)

General description.—As for *C. mimula.*

Facial mask (fig. 51).—As for *C. mimula* except that only 2 genal rami arise from each side of mouth opening ; these rami bifurcate less, thus forming fewer but larger cells.

Cephalo-pharyngeal skeleton (fig. 52).—Very similar to *C. mimula.*

Anterior spiracles.—As for *C. mimula.* Of those examined 88 per cent. had 4 digitations and 12 per cent. had 5.

Posterior spiracles.—As for *C. mimula.*

Spicular zones (figs. 53, 54).—Ventral distribution :

Zone I :		6–9 irregular broken rows of short linear groups of fine pointed spicules.
Zone II :		absent.
Zone III :		absent.
Zone 1	Anterior :	2 irregular broken rows of approximately linearly grouped very coarse rounded spicules.
	Posterior :	2 irregular broken rows of linearly grouped fine rounded spicules.
Zones 2–8	Anterior :	1 complete (present mid-ventrally) row of spaced very coarse rounded spicules.
	Posterior :	1 broken irregular row of spaced very coarse rounded spicules. 1 broken irregular row of finer rounded spicules.

Lipara Meigen

Lipara lucens Meigen

Larva partly described and figured by Brauer (1883), Wandolleck (1898), de Meijere (1902), Vimmer (1925) and Balachowsky and Mesnil (1935). The latter state that the larva overwinters in the terminal shoot of *Phragmites communis* L. I have not yet seen this larva but from existing descriptions it is characterised as follows :

Spicular zones absent except in prothorax which is pale brown and anteriorly bears 6 small lobes. Apical segment of antenna completely retracted within the basal. Posterior end of larva regularly rounded and bears a pair of small brown spiracular lobes.

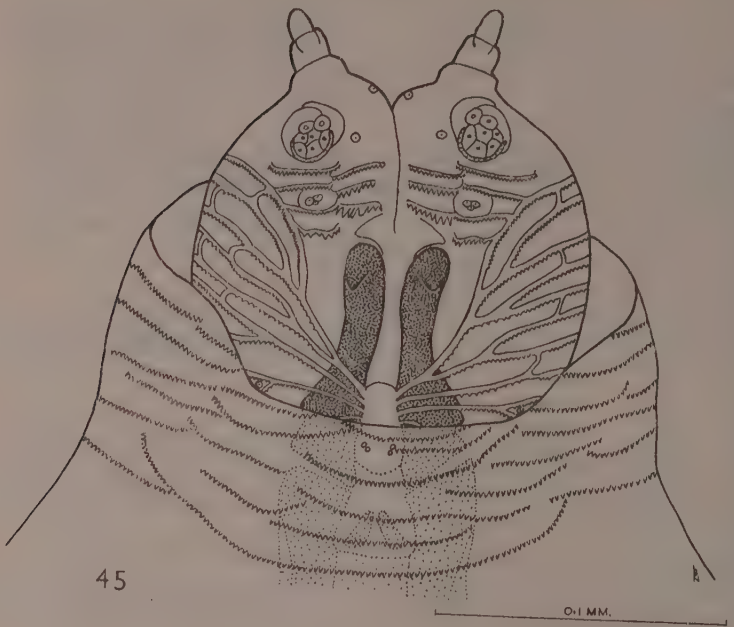
Calamoncosis Enderlein

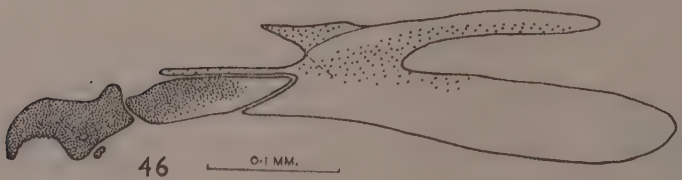
(*Stizambia* Enderlein)

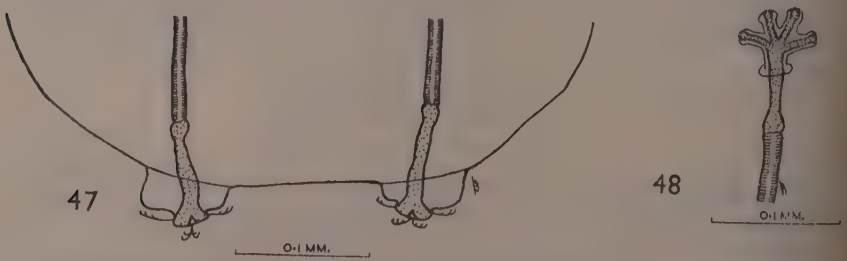
Calamoncosis minima Strobl

Larva described, and the facial mask figured, by d'Aguilar (1953), from a terminal shoot of *Phragmites communis* L. in May. I have not seen this larva but from the existing description it is characterised as follows :

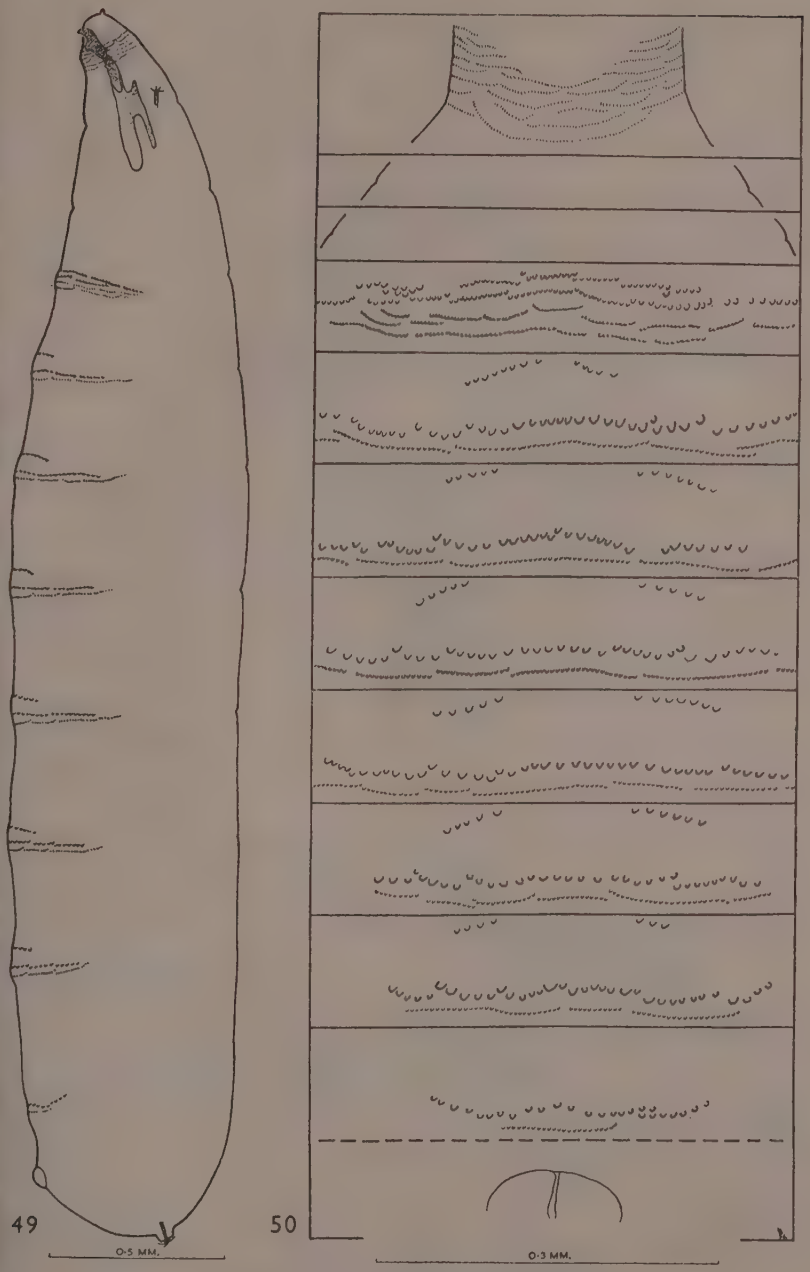
Up to 5 mm. long and spicular zones absent except on prothorax. Anterior spiracles with about 6 digitations and posterior ones borne on a brown tridentate spiracular lobe. Apical antennal segment projecting normally from the basal. Facial rami form a series of unornamented cells.



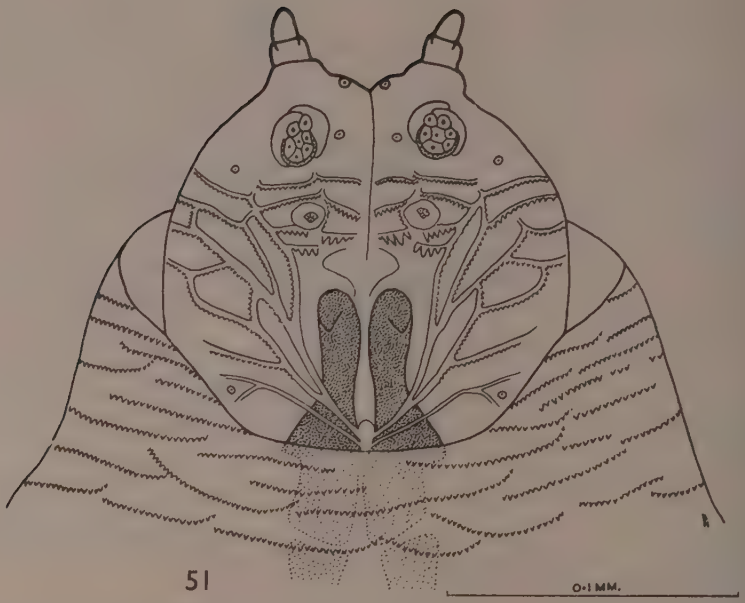


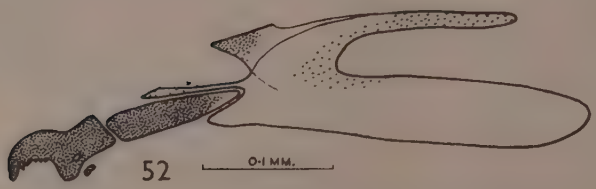


Figs. 45–48.—*Conioscinella minuta* Collin: (45) facial mask; (46) cephalo-pharyngeal skeleton; (47) posterior spiracles; (48) anterior spiracles.

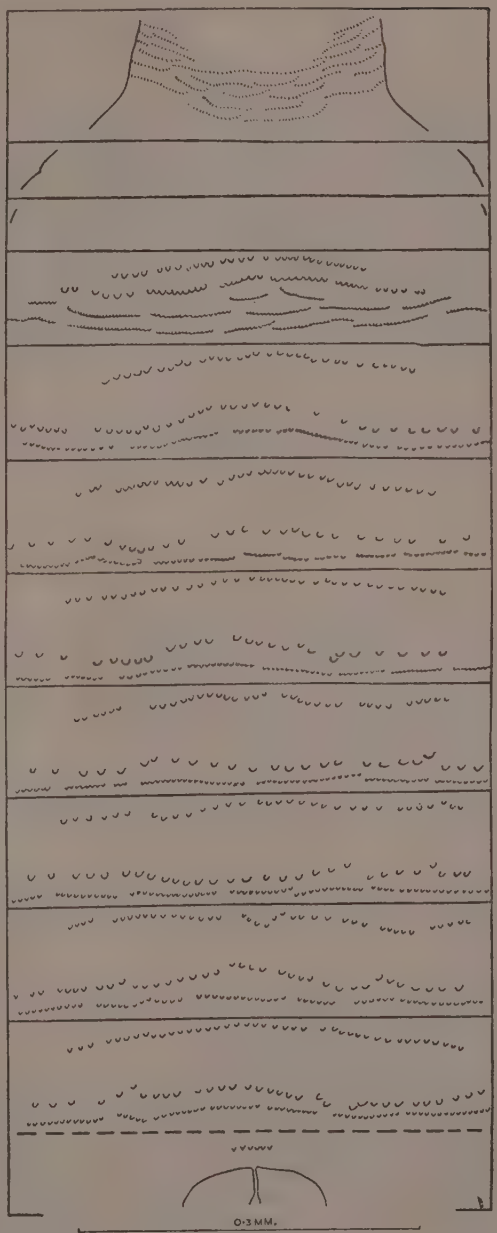


FIGS. 49–50.—*C. mimula :* spicular zones.





FIGS. 51–52.—*Conioscinella frontella* Fallén : (51) facial mask ; (52) cephalo-pharyngeal skeleton.



FIGS. 53–54.—*C. frontella* : spicular zones.

Oscinella Becker

Collin (1946) has been followed in the classification of this genus. Of the seven descriptions which follow five are of recognised species. The other two have not yet been named for, although the larvae are morphologically distinct, the adult material bred from them appears to be within the limits of variation of *O. frit* and a further study of the complex is required. For the present they have been termed *O. frit* ex *Anthoxanthum* and *O. frit* ex *Arrhenatherum* after the grasses in which they were most commonly found.

Balachowsky and Mesnil (1935) described four new species ; in two of them, *O. grossa* Mesn. (may = *pusilla* Meig. or close to it according to Collin (1946)) and *O. agropyri* Mesn., the imago is described and the larval spicules figured, while the other two, *O. festucae* Mesn. and *O. alopecuri* Mesn., appear only in a larval key and are not supported by a description of imago or larva. The larva of *O. vastator*, however, corresponds with *O. festucae*, within the limits of the brief description given in the key and my *O. frit* ex *Anthoxanthum* larva could fit the very brief description of *O. alopecuri*.

Oscinella frit Linnaeus

The Frit, or Swedish fly, is a serious pest of European cereals, especially of oats, and occurs also in North America where it mainly attacks wheat. The volume of literature concerning it is accordingly vast, but there is still no illustration or description of the larva by which it can be positively distinguished from other species. Previous partial descriptions and figures have been given by Hewitt (1914), Aldrich (1920), Kreuter (1928), Steel (1931), Oettingen (1935), Lazarov (1935), Balachowsky and Mesnil (1935) and Roos (1937).

Normally there are three generations per year, the first as a result of oviposition in May on young cereals or grass tillers, in which the larvae develop and pupate. The imago then emerges in July and lays on the glumes of the newly opened oat panicles, the larvae then developing in the milky grain and pupating alongside its shrivelled remains. If oat panicles are not available oviposition and development takes place on wild grass tillers. This second generation emerges in August and lays on volunteer cereals or again on wild grasses, where the larvae overwinter until they pupate the following April. Very careful examination of all the generations in oats has shown that the larvae and the limits of their variation are the same and no dimorphism exists between the tiller and panicle generations.

This is a highly polyphagous species and I have found the larva in *Festuca pratensis* Huds., *F. rubra* L., *Lolium perenne* L., *L. multiflorum* Lam., *Poa annua* L., *P. pratensis* L., *P. trivialis* L., *Holcus lanatus* L., *H. mollis* L., *Agrostis tenuis* Sibth., *A. canina* L., *A. stolonifera* L. and *Alopecurus pratensis* L. In addition *Arrhenatherum elatius* (L.), *Alopecurus pratensis* L. and *Anthoxanthum odoratum* L. all contain species which are extremely close to *O. frit*. It is probable that with further careful study it will be found that the *Oscinella* present in other grass species may have to be separated from *O. frit*. sensu

stricto, *e.g.* the larvae found in *Festuca rubra* L. are not quite typical *frit* and require further study.

Third Instar Larva (figs. 55–60)

General description.—Creamy-white typically acalypterate larva up to approximately 5 mm. long and 0·5 mm. diameter. In ventral view the antennae visible as minute uncoloured projections; neither maxillary palps, dentate sclerite nor any of thoracic or abdominal spicules visible: posterior spiracles borne on a pair of small discrete lobes. In lateral view cephalo-pharyngeal skeleton anteriorly black, medially pale brown and posteriorly a darker brown; anterior spiracles of the fan type but inconspicuous.

Facial mask (fig. 55) surmounted by unsclerotised antennae. Maxillary palps slightly tanned and of the open type; frontal palps prominent. Labral lobes usually plain but with tendency to be slightly serrate. Genal rami run anteriorly from mouth opening, bifurcating and anastomosing to form a series of about 8 cells on the jowls and 1 both anterior and posterior to frontal palps. Between frontal palps anterior pair of mid-frontal rami plain to crenulate, mid pair crenulate to serrate and posterior pair more or less strongly toothed. Directly anterior and posterior to frontal palp borders of cells usually plain but may be slightly crenulate. All remaining rami of mask plain.

Cephalo-pharyngeal skeleton (fig. 56).—Apical tooth followed by 3 or 4 smaller teeth. Ventral to mouth-hooks the dentate sclerites paired, small and inconspicuous. Anteriorly intermediate sclerite heavily tanned but becoming less so posteriorly before meeting the pharyngeal sclerite. Dorsal sclerite, dorsal wing and only upper part of ventral wing tanned. In ventral view dentate sclerite not visible and liguloid plates appear as triangles just anterior to hypostomal arch.

Anterior spiracles (fig. 58) of the fan type and pale brown by transmitted light, projecting from prothorax in a plane at right angles to that of body. Of those examined 5 per cent. had 4 digitations, 76 per cent. had 5, 15 per cent. had 6 and 4 per cent. had 7.

Posterior spiracles (fig. 57).—Spiracular trunks pale brown, slightly gnarled and protruding a little as " bosses " from spiracular lobes. The 4 tufts of branched hairs present.

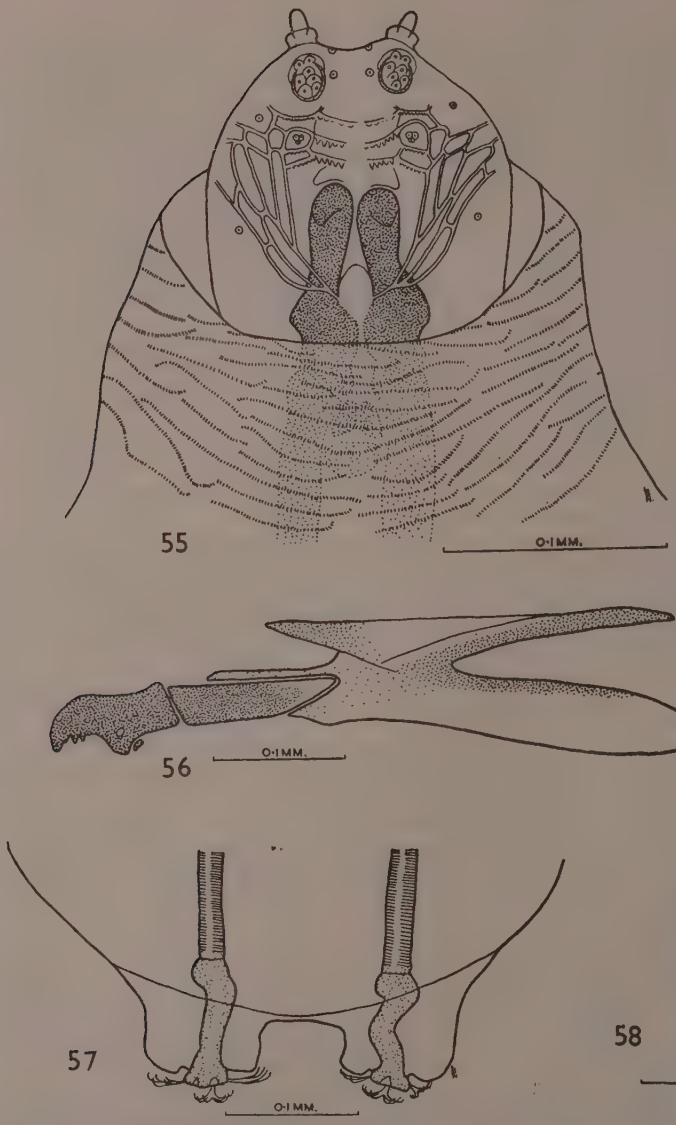
Spicular zones (figs. 59, 60).—Ventral distribution:

Zone I:	9–13 irregular broken rows of linearly grouped fine pointed spicules.
Zone II:	3–5 irregular broken rows as preceding.
Zone III:	2–4 irregular broken rows of linearly grouped fine rounded spicules.
Zone 1:	2–4 irregular broken rows as preceding.
Zones 2–8:	1–3 irregular broken rows as preceding.
Anal zone:	a few groups each of up to 15 fine rounded spicules just anterior and posterior to anus.

Second and First Instar Larvae

In the second instar larva the characters, in particular the facial rami, are reduced and although plainly an *Oscinella* it is not possible to distinguish the species for certain. In addition, although the spicules follow the same general pattern, there are in the anterior row of each of the second to eighth abdominal segments, individual spicules which are about twice the width of those in the following rows, giving an appearance very similar to that of the third instar of *O. frit* ex *Arrhenatherum* (fig. 62). It must be noted that this tendency can often still be seen in the third instar of *O. frit*.

In the first instar further reductions take place as indicated in the section on General Morphology.



FIGS. 55–58.—*Oscinella frit* L.: (55) facial mask; (56) cephalo-pharyngeal skeleton; (57) posterior spiracles; (58) anterior spiracles.

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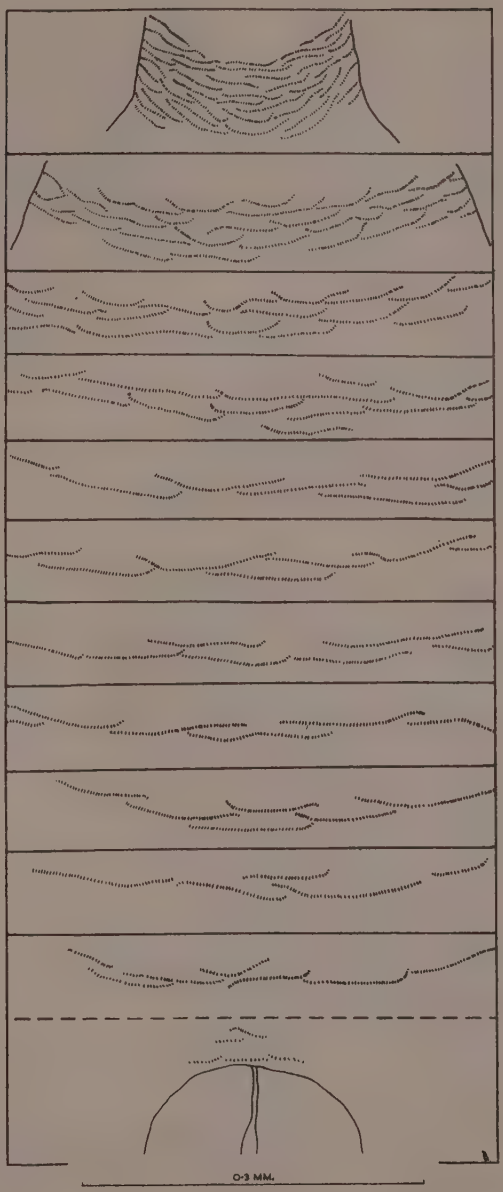

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FIGS. 59–60.—*O. frit* : spicular zones.

Oscinella frit ex *Arrhenatherum*

This larva is sufficiently morphologically distinct from that of *O. frit* to justify a separate description but the bred adults are within the present limits of variation of *frit*. The tibiae are, however, nearly always all entirely black and the tarsi very dark. The larva overwinters in the basal tillers of *Arrhenatherum elatius* and pupates in April. The adults emerge in May, oviposit, and the larvae develop in the basal tillers or at the upper aerial node of *A. elatius*. The second generation in July can again attack basal tillers or the growing point of aerial culms, while the third in August–September develops in the basal tillers.

Third Instar Larva (figs. 61, 62)

General description.—Differs from *O. frit* only in slight tendency to be larger and yellower.
Facial mask.—As for *O. frit.*
Cephalo-pharyngeal skeleton.—As for *O. frit.*
Anterior and posterior spiracles.—As for *O. frit.*
Spicular zones (figs. 61, 62).—Differs from *O. frit* in that in each spicular zone of second to eighth abdominal segments the anterior row of spicules is composed of individual rounded spicules up to twice the width and usually less compact than those in the following row(s).

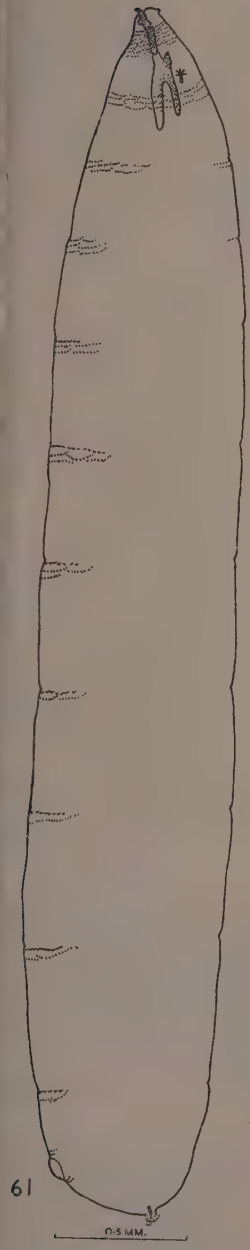
Oscinella frit ex *Anthoxanthum*

This is another larva which is sufficiently morphologically distinct to justify a separate description, but again the bred adults are within the present limits of variation of *O. frit*. The wings, however, appear shorter and darker but a detailed study of the *frit* complex will be necessary to establish this. In Balachowsky and Mesnil (1935) this larva runs down in the key to *O. alopecuri* Mesnil but there is no further supporting description of larva or imago. It overwinters at Silwood Park in the basal tillers of *Anthoxanthum odoratum* L. and *Alopecurus pratensis* L. Pupation occurs in April and emergence in May.

Third Instar Larva

General description.—As for *O. vastator.*
Facial mask.—As for *O. vastator.*
Cephalo-pharyngeal skeleton.—As for *O. vastator.*
Anterior and posterior spiracles.—As for *O. frit.*
Spicular zones.—Ventral distribution resembles that of *O. vastator*, but more groups of spicules often present in Zone III, and in Zones 2–8 no single anterior row of coarse spicules separated off from the following rows.

Zone I :	8–12 irregular rows of linearly grouped fine pointed spicules.
Zone II :	3–4 irregular rows as preceding.
Zone III :	absent or a single weak line of scattered linear groups of fine spicules.
Zone 1 :	1–2 very short rows of linearly grouped coarse rounded spicules. 2–3 irregular rows of finer rounded spicules.
Zones 2–8 :	single irregular row of linearly grouped coarse rounded spicules followed by a single irregular row of linearly grouped much finer rounded spicules.
Anal zone :	a few fine pointed spicules at anterior of anus.



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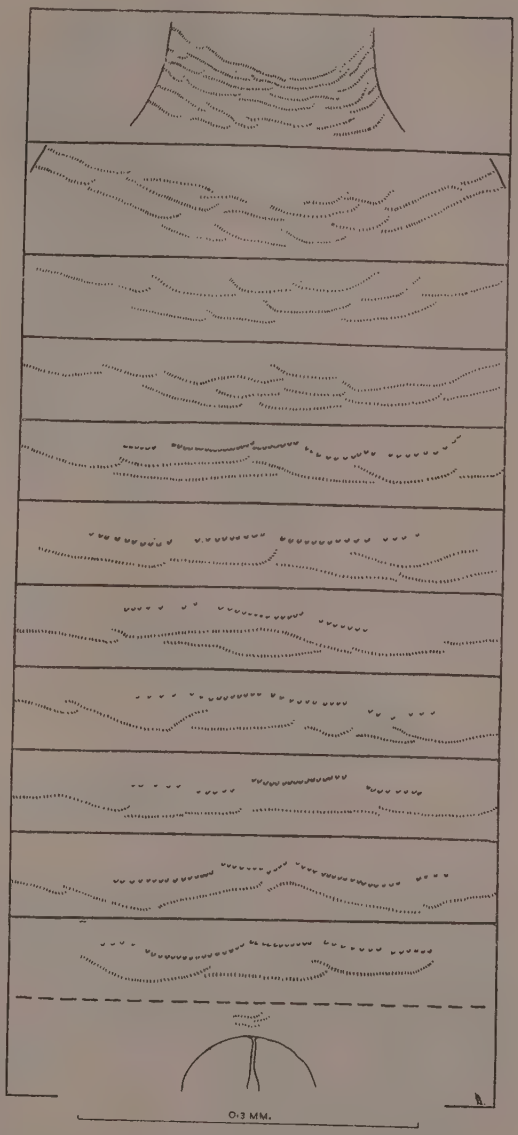

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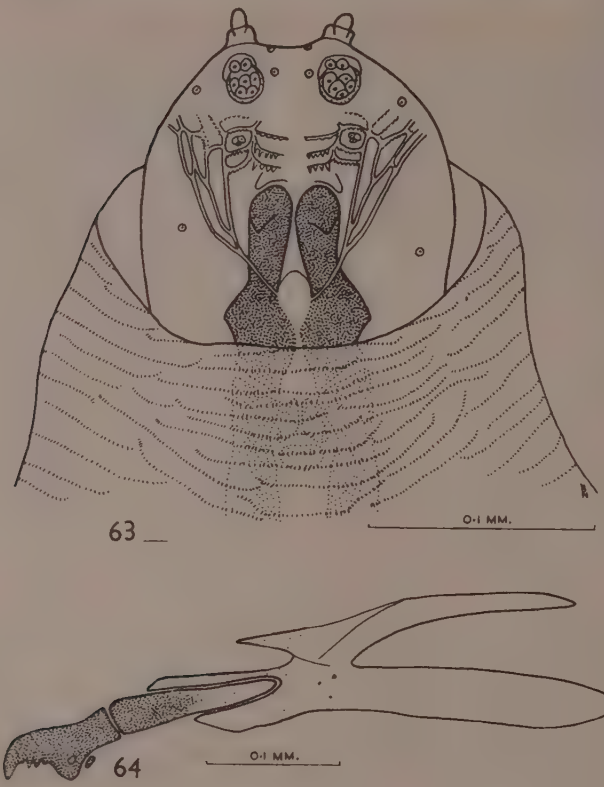
FIGS. 61–62.—*O. frit* ex *Arrhenatherum* : spicular zones.



FIGS. 63–64.—*Oscinella nitidissima* Meigen : (63) facial mask ; (64) cephalo-pharyngeal skeleton.

Oščinella nitidissima Meigen

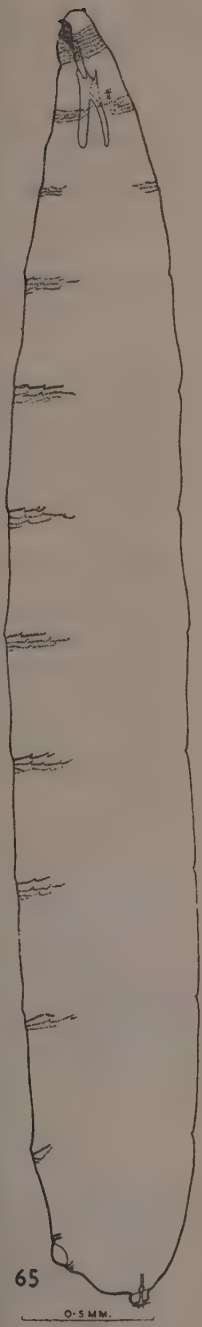
Collin (1946) considers that this species has been described by Duda (1933) as *O. frit* var. *atricilla* Zett. The larva has not previously been described or figured. The overwintering larvae have been found in the basal tillers of *Agrostis tenuis* Sibth., *A. stolonifera* L. and *A. canina* L. Pupation takes place in April and the adults emerge in May, and oviposit on basal or aerial shoots of *Agrostis*. There is at least one summer generation.

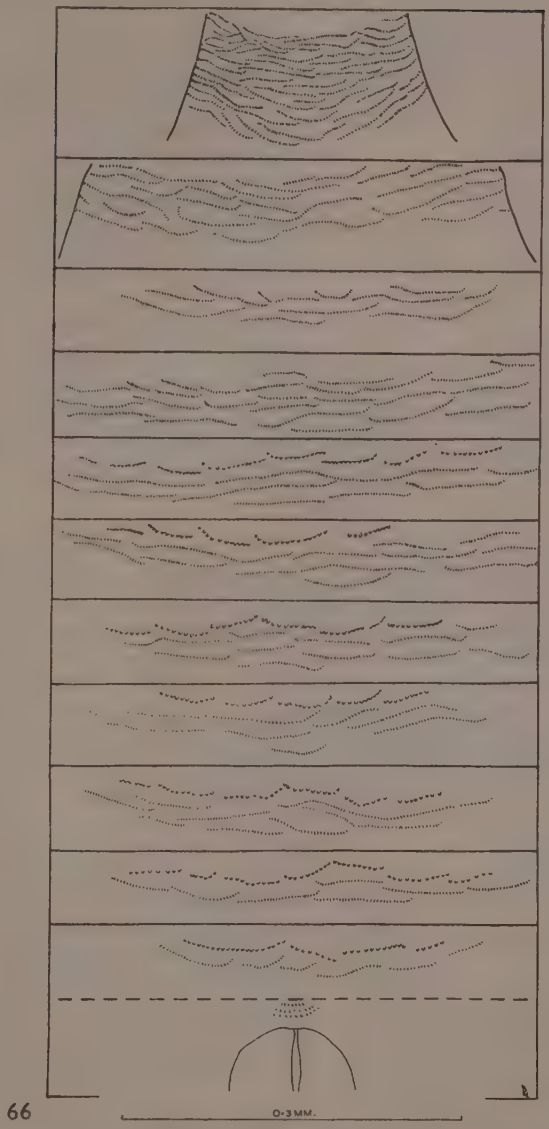
Third Instar Larva (figs. 63–66)

General description.—As for *O. frit*.

Facial mask (fig. 63).—Differs from *O. frit* in having outer genal rami reduced. In *O. frit* genal ramus running anteriorly from the mouth soon trifurcates, whereas in *O. nitidissima* it bifurcates only ; outer ramus and cells it forms are therefore missing or only faintly seen—a difficult and variable character but the only one on the facial mask.

Cephalo-pharyngeal skeleton (fig. 64).—As for *O. frit* except that dorsal and ventral wings of pharyngeal sclerite not usually tanned.





FIGS. 65–66.—*O. nitidissima* : spicular zones.

Anterior spiracles.—Of those examined 58 per cent. had 5 digitations, 25 per cent. had 6 and 17 per cent. had 7.

Posterior spiracles.—As for *O. frit.*

Spicular zones (figs. 65, 66).—Ventral distribution :

Zone I :	9–13 irregular rows of linearly grouped fine pointed spicules.
Zone II :	3–5 irregular rows as preceding.
Zone III :	2–4 irregular rows of linearly grouped fine rounded spicules.
Zone 1 :	3–5 irregular rows as preceding.
Zones 2–8 :	single irregular row of loosely grouped coarse rounded spicules, followed by 1–3 irregular rows of linearly grouped fine rounded spicules.
Anal zone :	a few fine pointed spicules just anterior and posterior to anus.

Oscinella vastator Curtis

The larva of this species runs down in Balachowsky and Mesnil (1935) to *O. festucae* Mesnil but this name is unsupported by any further description. At Silwood Park it overwinters in the basal tillers of *Lolium perenne* L., *L. multiflorum* Lam., *Festuca pratensis* Huds. and *Phleum pratense* L. Pupation occurs in April and the adults emerge in May. There is at least one summer generation.

Third Instar Larva (figs. 67–70)

General description.—Differs from *O. frit* in being generally yellower and plumper (diameter up to 0·75 mm.).

Facial mask (fig. 67).—Differs characteristically from *O. frit* in having entirely plain frontal rami. (Occasionally there is a slight crenulation of the posterior pair of the mid-frontal rami.) Antennae mounted on a pair of anterior lobes making them appear 3-segmented.

Cephalo-pharyngeal skeleton (fig. 68).—As for *O. frit* except that ventral wing of pharyngeal sclerite not usually tanned.

Anterior spiracles.—Of those examined 7 per cent. had 5 digitations, 39 per cent. had 6, 50 per cent. had 7 and 4 per cent. had 8.

Posterior spiracles.—As for *O. frit.*

Spicular zones (figs. 69, 70).—Ventral distribution :

Zone I :		8–12 irregular rows of linearly grouped fine pointed spicules.
Zone II :		3–4 irregular rows as preceding.
Zone III :		absent or at the most with 3 linear groups each of up to 20 fine rounded spicules.
Zone 1	Anterior :	2 short rows of linearly grouped coarse rounded spicules.
	Posterior :	3–5 irregular rows of grouped finer rounded spicules.
Zones 2–8	Anterior :	single irregular short row of linearly grouped coarse rounded spicules, distinctly separated from the following rows.
	Posterior :	single irregular row of linearly grouped coarse rounded spicules immediately followed by 1–2 irregular row(s) of linearly grouped finer rounded spicules.

Oscinella albiseta Meigen

Balachowsky and Mesnil (1935) have described the larva of this species and figured the spicules which, although similar to figure 73 up to the first abdominal segment, differ from then on. At Silwood Park the larva overwinters in the basal tillers of *Dactylis glomerata* L. Pupation occurs in May and emergence in early June. Oviposition on the same host then takes place, giving rise to a generation in August which in its turn produces the overwintering larvae.

Third Instar Larva (figs. 71–73)

General description.—As for *O. frit.*

Facial mask (fig. 71) very similar to that of *O. frit* except that mid-frontal rami and cells fore and aft of frontal palp all much more strongly toothed.

Cephalo-pharyngeal skeleton.—As for *O. frit.*

Anterior spiracles.—Of those examined 10 per cent. had 6 digitations, 70 per cent. had 7 and 20 per cent. had 8.

Posterior spiracles.—As for *O. frit.*

Spicular zones (figs. 72, 73).—Ventral distribution :

Zone I :		8–12 irregular rows of linearly grouped fine rounded spicules.
Zone II :		3–5 irreglar rows as preceding.
Zone III :		absent or, at the most, with 3 linear groups each of up to 30 fine rounded spicules.
Zone 1	Anterior :	2 short rows of grouped coarse rounded spicules.
	Posterior :	3–5 irregular rows of linearly grouped rounded spicules tending to be slightly finer and more compactly grouped.
Zones 2–8	Anterior :	single short row of linearly grouped coarse rounded spicules, distinctly separated from the following rows.
	Posterior :	3–5 irregular rows of linearly grouped rounded spicules tending to be slightly finer and more compactly grouped.

Oscinella trochanterata Collin

Larva partly described and figured by Balachowsky and Mesnil (1935) as *O. gracilior* de Meij., but Collin (1946) considers that de Meijere's species is an *Eribolus* and accordingly he has renamed the species which Mesnil refers to as *O. gracilior* de Meij. and has now described the imago as *O. trochanterata* Collin.

This species overwinters as larvae in the shoots of *Phalaris arundinacea* L. Pupation occurs in April and emergence of adults in May. These adults lay in the basal tillers and the following generation, emerging in August, oviposit in the aerial shoots and give rise to the overwintering larvae.

Third Instar Larva (figs. 74–77)

General description.—As for *O. frit.*

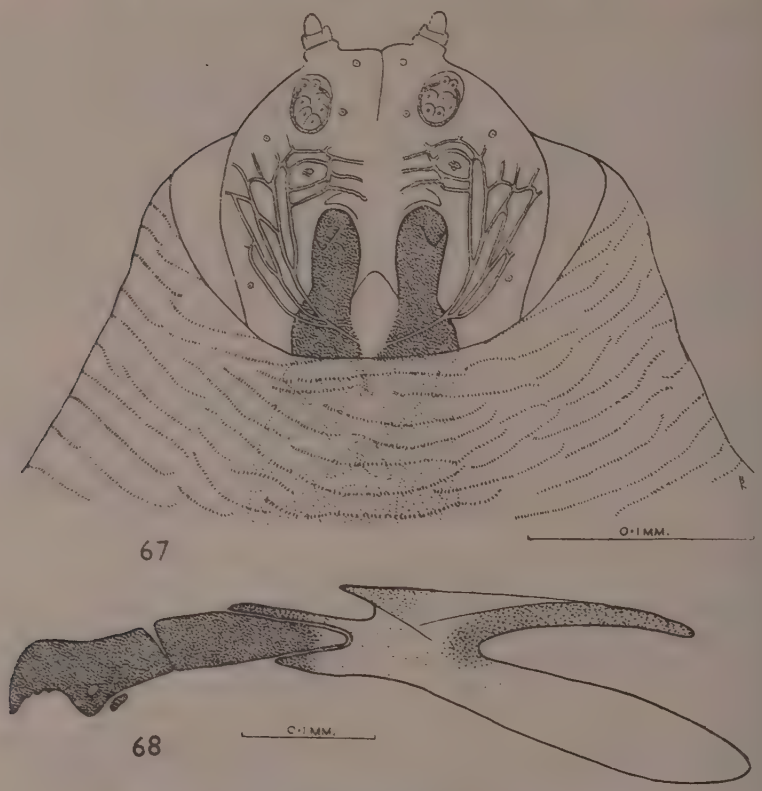
Facial mask (fig. 74).—Differs from *O. frit* in having both frontal and genal rami greatly reduced.

Cephalo-pharyngeal skeleton (fig. 75).—Ventral wing of pharyngeal sclerite relatively deeper dorsoventrally and less tanned than in *O. frit.*

Anterior and posterior spiracles.—As for *O. frit.*

Spicular zones (figs. 76, 77).—Ventral distribution :

Zone I :		8–12 irregular broken rows of linearly grouped fine pointed spicules.
Zone II :		absent.
Zone III :		absent.
Zone 1	Anterior :	2–3 short rows of linearly grouped coarse rounded spicules.
	Posterior :	2–3 irregular rows of linearly grouped fine rounded spicules.
Zones 2–8	Anterior :	2–3 very irregular rows of grouped coarse rounded spicules.
	Posterior :	1–2 very irregular rows of grouped very coarse spicules followed by a single often short irregular row of grouped finer rounded spicules.



FIGS. 67–68.—*Oscinella vastator* Curtis : (67) facial mask ; (68) cephalo-pharyngeal skeleton.

Camarota Meigen

" (*Oscinis* Becker)

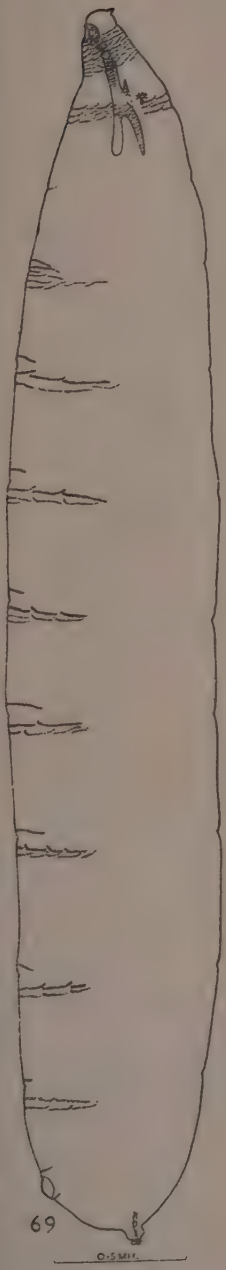
Camarota curvipennis Latreille

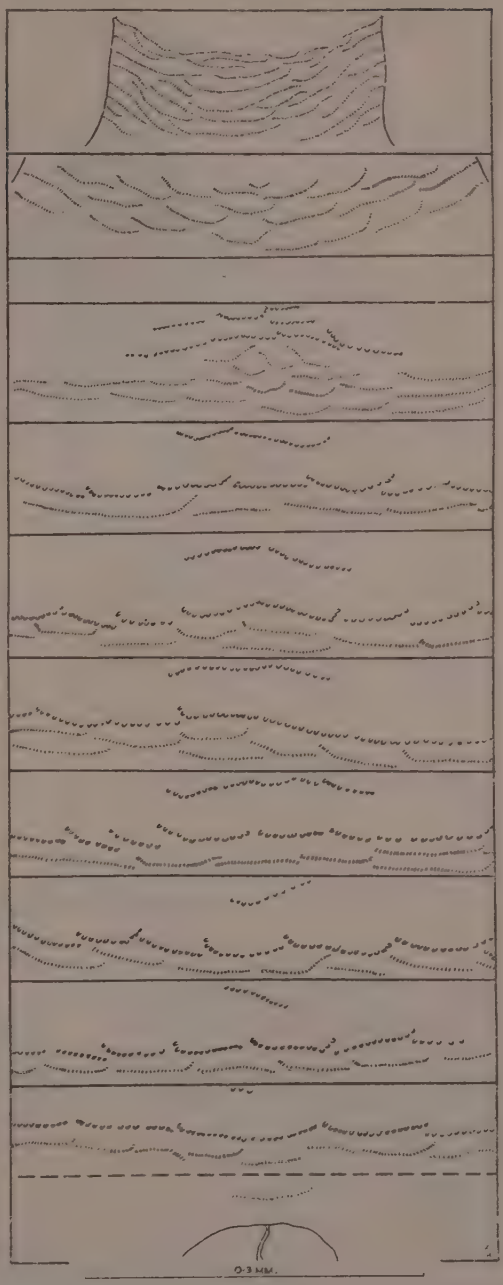
(*C. curvinervis* auct., *see* Coe, 1942, *Proc. R. ent. Soc. Lond.* (B) **11** : 141).
(*C. cerealis* Rondani).
(*C. flavitarsis* Meigen).

The larva of this species has been described and illustrated by Balachowsky and Mesnil (1935). The adults emerge in May and on the Continent oviposit principally on rye but also on wheat and barley. The larvae feed on the developing ear and the adults emerge in July. It has yet to be determined where this generation oviposits.

I have not yet seen the larva but according to Mesnil it is characterised among other features by its agility and as follows :

Thoracic spicular zones absent ventrally, lightly tanned posterior spiracular lobes terminating in the shape of a 3-pointed star and with no branched hairs.





FIGS. 69–70.—*O. vastator :* spicular zones.

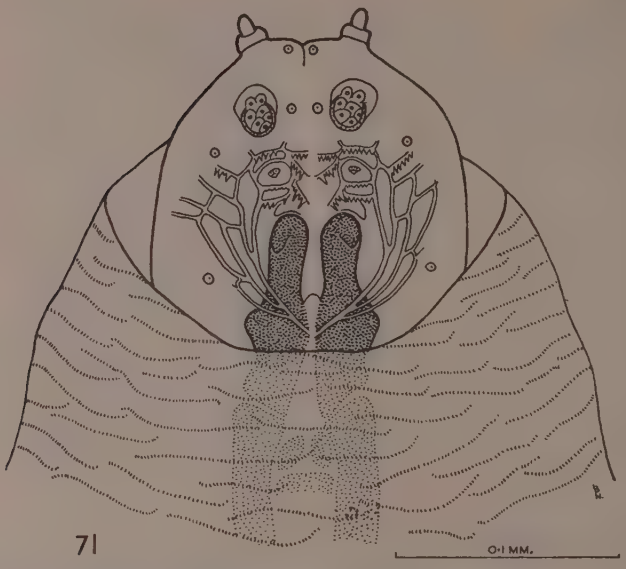


FIG. 71.—*Oscinella albiseta* Meigen : facial mask.

Lasiosina Becker

Lasiosina cinctipes Meigen

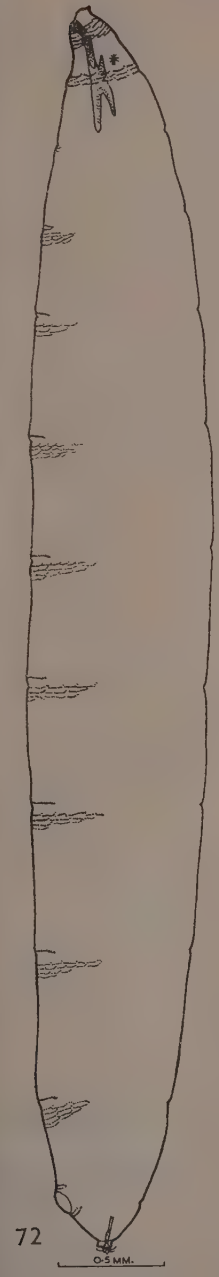
(*L. limbata* Meigen).
(*L. inconstans* Loew).

The larva of this species has been partly described and figured by Kreuter (1928), Oettingen (1935) and Balachowsky and Mesnil (1935).

The adults appear early in June and oviposit usually, but not always, on barley which has already been attacked by *Chlorops pumilionis*. This generation emerges in late July to August and the eggs laid develop and overwinter in decaying leaves and shoots.

I have been unable to find the larva but from Mesnil's description it is characterised as follows :

A complex facial mask consisting of about 5 frontal and 5 bifurcating genal rami all of which bear spicules. Prothorax bears spicules but meso- and metathorax do not. Abdominal spicular zones well represented though each has the anterior rows interrupted in the mid-ventral line ; anus completely surrounded by large well developed spicules.



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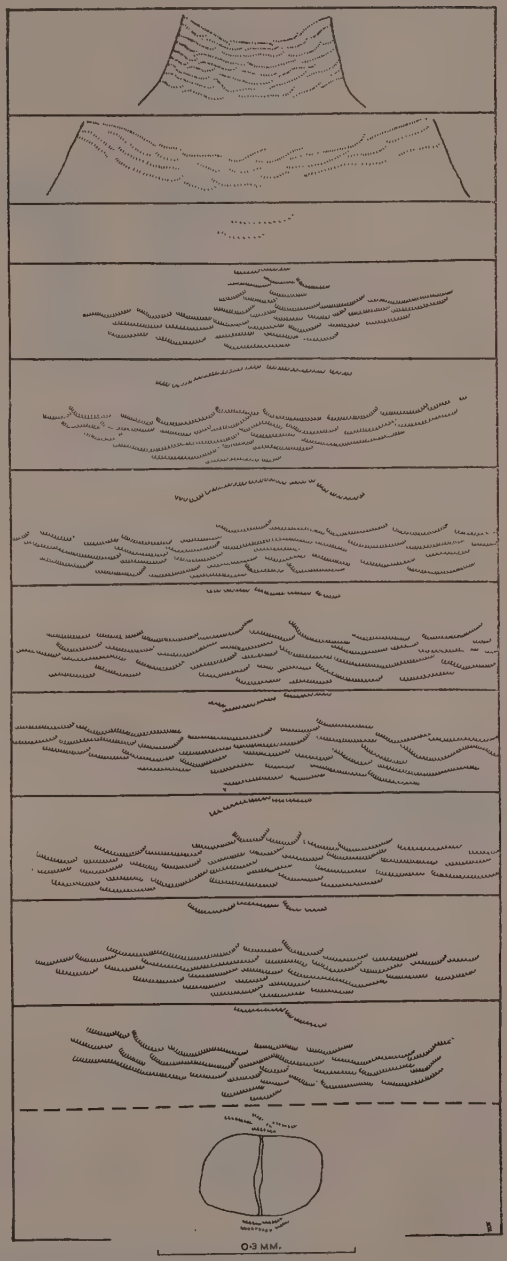

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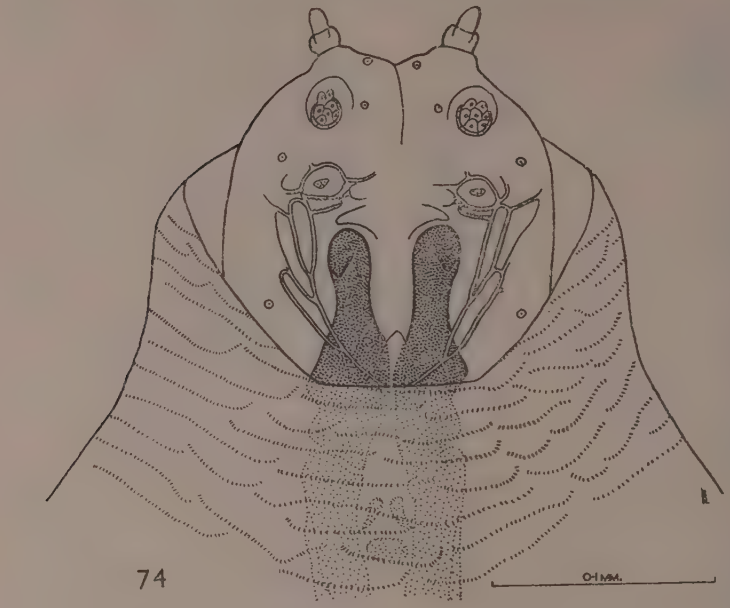
FIGS. 72–73.—*O. albiseta* : spicular zones.



FIGS. 74–75.—*Oscinella trochanterata* Collin : (74) facial mask ; (75) cephalo-pharyngeal skeleton.

Anthracophaga Loew

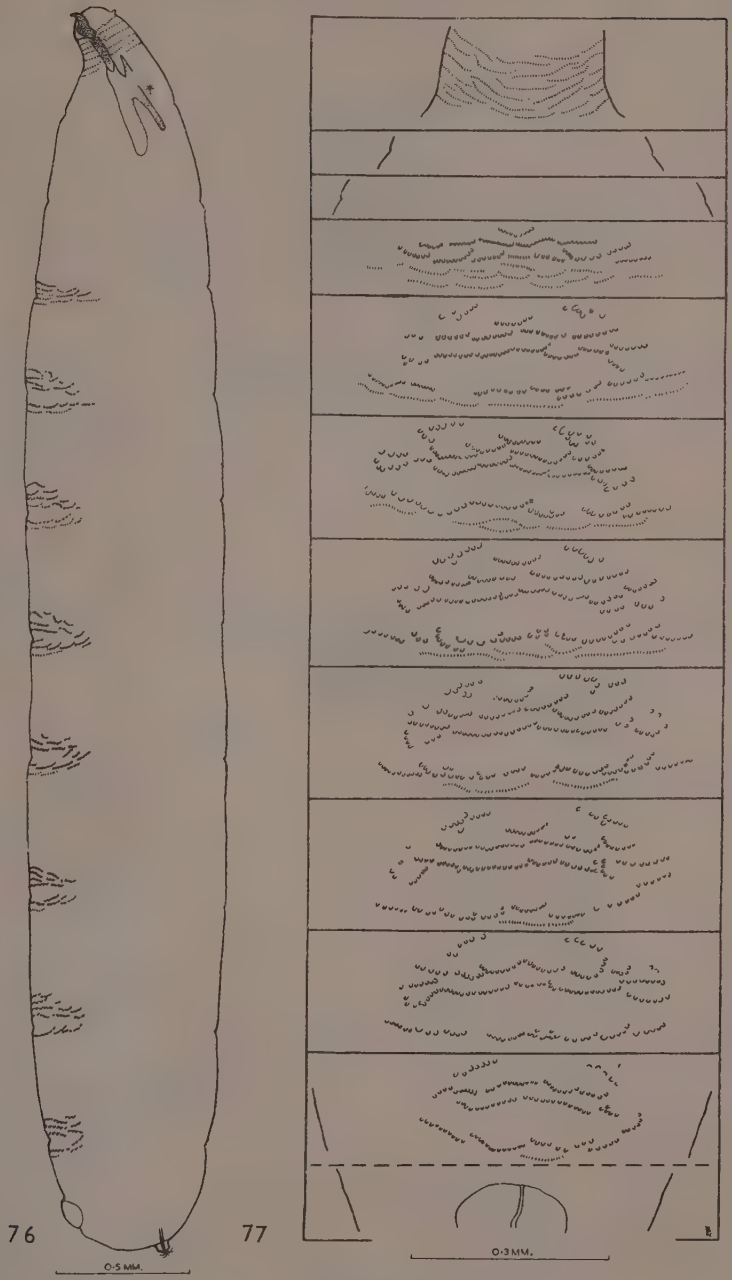
Anthracophaga strigula Fabricius

(*A. cingulata* Meigen).

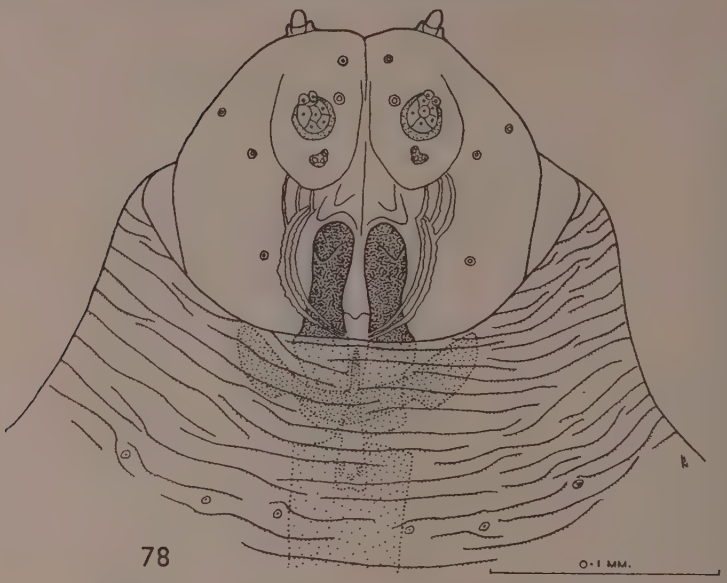
The larva of this species has been partly described and figured by Oettingen (1935) and Balachowsky and Mesnil (1935).

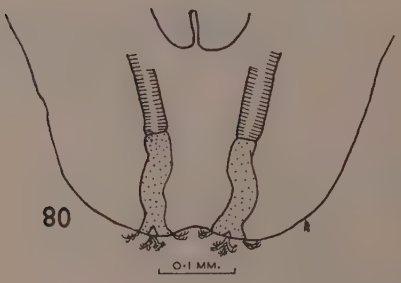
I have not seen this larva which, according to Mesnil, overwinters in species of *Brachypodium* and *Agropyrum*, in which it pupates in April and then emerges in May.

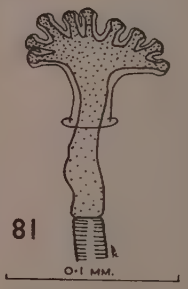
Larva characterised by its oval flattened shape and small retracted head, together with posterior spiracles which scarcely project from the almost semicircular anal segment.

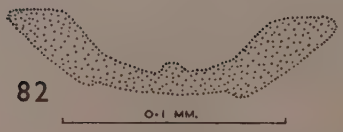


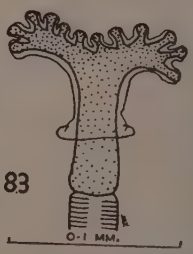
FIGS. 76–77.—*O. trochanterata :* spicular zones.











Figs. 78–81.—*Meromyza variegata* Meigen : (78) facial mask ; (79) cephalo-pharyngeal skeleton ; (80) posterior spiracles ; (81) anterior spiracles.
Figs. 82–83.—*Meromyza pratorum* Meigen : (82) dentate sclerite ; (83) anterior spiracles.

Meromyza Meigen

Meromyza variegata Meigen

The larva has been partly described and figured by Balachowsky and Mesnil (1935). At Silwood Park it overwinters in the basal tillers of *Dactylis glomerata* L., where it pupates in early June and the adult emerges in July. These live about a month and during this time oviposit on the basal tillers of the same grass, in which they develop slowly and pass the winter.

Third Instar Larva (figs. 78–81)

General description.—A typically acalypterate larva, up to 10 mm. long and 1 mm. diameter, characteristically blue-green throughout with yellow patches particularly posteriad in anal segment. Depth of colour varies between specimens and may be very pale. A prominent brown crescentic dentate sclerite present but, apart from cephalo-pharyngeal skeleton which appears black throughout, no other cephalic features visible. Anterior spiracles of rosette type and small, the posterior spiracles not borne on lobes and closely apposed.

Facial mask (fig. 78).—Antennae small, well separated, and distal segment light brown and partially retracted within the basal segment which forms a cup. A slight median groove present on either side of which are situated the light brown open type maxillary palps. Frontal palps consisting of 3 papillae on a small lightly tanned plate. Maxillary and frontal palps together with maxillary papillae mediad to maxillary palp; all lie on a large otherwise bare area, giving a characteristic appearance to the mask. Posterior to this area are 2–3 rami slightly crenulate on the outer edges running longitudinally, and joining 2–3 crescentic genal rami which are also crenulate. Dentate sclerite distinct, light brown and crescentic with the arms expanded to form wings the tips of which point anterolaterally. Cephalic papillae in the form of small light brown rings.

Cephalo-pharyngeal skeleton (fig. 79).—Apical tooth followed by 3 or 4 smaller teeth. A single crescentic dentate sclerite as described above. Intermediate sclerites fused to the relatively long and narrow pharyngeal sclerite. Whole skeleton (except for part of dorsal and ventral wings) densely tanned throughout.

Anterior spiracles (fig. 81) of a transversely elongate rosette type. Of those examined 17 per cent. had 7 digitations, 46 per cent. had 8 and 37 per cent. had 9.

Posterior spiracles (fig. 80) borne on very small spiracular lobes, separated only by a slight depression; the spiracles themselves close and tending to incline towards one another. The 4 tufts of branched hairs present.

Spicular zones each consist of numerous irregular lines of overlapping striae bearing minute spicules spaced throughout their length; the lines of each zone closer together anteriorly and extending the full width of the larva but becoming more widely spaced and shorter posteriorly making the spicular zone appear as a broad V. In each of abdominal zones, posterior to apex of V, is a gap and then about 5 very short rows in the centre of each segment.

Ventral distribution:

Zone I:	20–25 irregular lines of overlapping striae.
Zone II:	25–30 as above.
Zone III:	25–35 as above.
Zones 1–8	20–30 as preceding, followed, after a gap, by 0–6 very short lines of striae.

Meromyza saltatrix Linnaeus

The larva of this species has been partly described and figured by Frew (1923) (as its variety *nigriventris* Macq.), Kreuter (1928), Oettingen (1935) and Balachowsky and Mesnil (1935).

This species is similar in all respects to *M. variegata* except that it is associated with grasses other than *Dactylis*. On the Continent it is a pest of wheat and has a second generation which attacks the ear while it is still within the leaf sheaths. Rearing is even more difficult with this than with other genera and I have not succeeded in obtaining third instar larvae from identified parents.

Larvae so similar to *M. variegata* that it has not been possible to separate them satisfactorily. Smaller and their dentate sclerite narrower and with less pronounced wings, the tips of which point anterolaterally. Mesnil separates the two species on the shape and degree of retraction of the antennae but I have found this to be equally unsatisfactory.

Meromyza pratorum Meigen

The larva of this species has been described by Balachowsky and Mesnil (1935), who found that it overwintered in the basal tillers of *Ammophila arenaria* L. The adults emerge in July and there is only one generation per year.

I have seen a few specimens from the same grass from Cornwall, but have been unable to rear the adults.

Larvae very similar to those of *M. variegata* but the anterior spiracles more transversely rosette-shaped and usually with 10 or 11 digitations (fig. 83). In addition wings of dentate sclerite point laterally instead of anterolaterally (fig. 82).

Cetema Hendel

(*Centor* Loew).

Cetema neglecta Tonnoir

At Silwood Park the larva of this species has been found overwintering in the basal tillers of *Lolium perenne* L., *Festuca pratensis* Huds., *Poa trivialis* L. and *Agrostis* spp. Pupation takes place in May and the adults emerge in late June and live for about a month. There is only one generation per year.

This larva is very similar to that of *C. elongata* and the suggestion that they may be distinguished on differences between the spicular zones is put forward tentatively until further confirmation is obtained. It has been found very difficult to breed these species since they are univoltine and development is slow.

A further species, *C. myopina* Loew, which is very close to *neglecta* has been recorded from spring oats by Hodson (1926). It is probable that this attack was due to larval migration from a ploughed-in ley.

Third Instar Larva (figs. 84–89)

General description.—A typically acalypterate creamy-yellow larva up to 8 mm. long and 0·8 mm. diameter. Cephalo-pharyngeal skeleton heavily tanned and in ventral view no dentate sclerite or other cephalic feature visible. Anterior spiracles of the fan type and small. Abdomen deeply divided posteriorly into 2 large spiracular lobes between which detritus often collects, tending to obscure the division.

Facial mask (fig. 84) surmounted by the unsclerotised antenna. Maxillary palps of the open type. Frontal palp of about 3 small papillae in a conspicuous triangular cell, the largest in the mask, and bearing long pointed spicules on 2 or all of its sides. No other rami between each maxillary and frontal palp but a spiculate mid-frontal ramus present. Two genal rami arise from each side of mouth opening, bifurcating anteriorly to form a simple mask of about 4 spiculate cells.

Cephalo-pharyngeal skeleton (fig. 85).—Apical tooth of mouth-hooks followed by 3–4 smaller teeth ; beneath each mouth-hook a small inconspicuous dentate sclerite. Whole skeleton except for posterior half of ventral and sometimes tip of dorsal wing of pharyngeal sclerite densely tanned.

Anterior spiracles (fig. 87) of the fan type. Of those examined 10 per cent. had 4 digitations, 42 per cent. had 5, 42 per cent. had 6 and 6 per cent. had 7.

Posterior spiracles (fig. 86) small but borne on 2 very large spiracular lobes, well separated by a deep channel. The 4 tufts of branched hairs present.

Spicular zones (figs. 88, 89) each consists of numerous long but broken and overlapping irregular striae bearing minute spicules throughout their length. In fourth to eighth abdominal spicular zones up to 3 or 4 short additional broken rows of fine pointed spicules, occurring to the anterior of the usual striae, also present.

Ventral distribution :

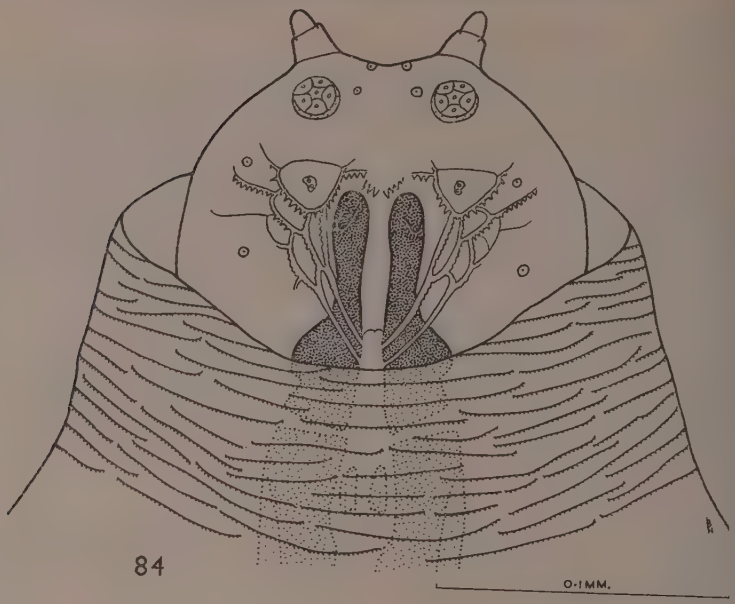
Zone I :		8–13 irregular rows of overlapping striae.
Zone II :		10–15 as preceding.
Zone III :		10–15 as preceding.
Zone 1 :		8–13 as preceding.
Zone 2 :		6–10 as preceding.
Zone 3 :		6–10 as preceding.
Zones 4–8	Anterior :	1–4 short irregular rows of linearly grouped fine pointed spicules.
	Posterior :	4–8 irregular rows of overlapping striae.
Anal zone :		a few scattered groups of fine pointed spicules around anus.

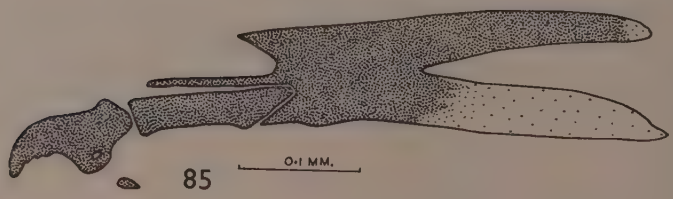
Cetema elongata Meigen

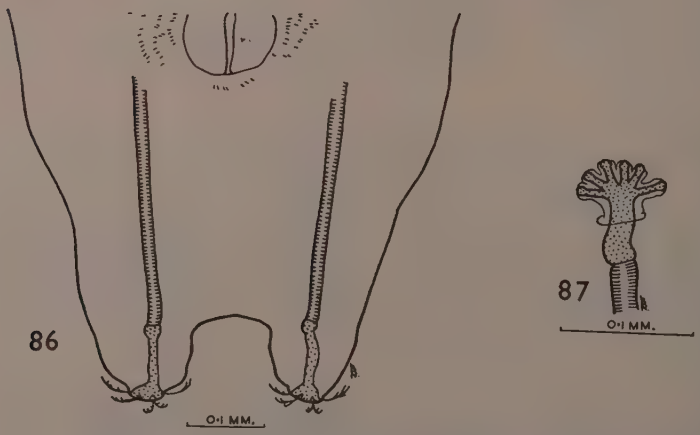
(*C. nudipes* Loew).

Larva partly described and figured by Kreuter (1928) and Balachowsky and Mesnil (1935). This species has a similar univoltine life cycle to that of *neglecta*, and at Silwood Park overwinters in the basal shoots of *Agrostis tenuis* Sibth., *A. stolonifera* L. and *A. canina* L.

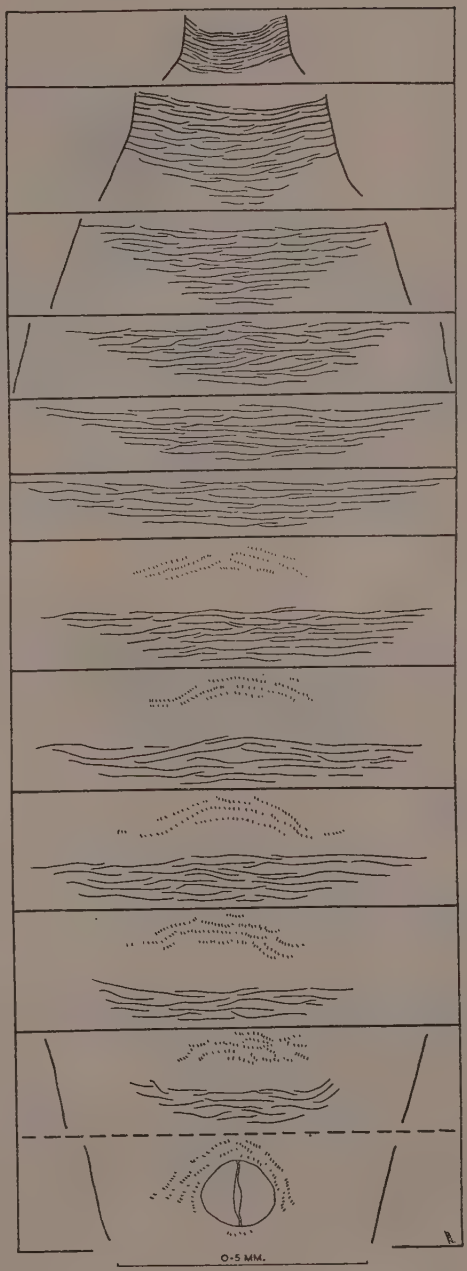
It is not yet certain how the larva of *elongata* can be distinguished from *neglecta*. A possible character may be the absence in *elongata* of the 1–4 short irregular rows of linearly grouped fine pointed spicules which occur in the fourth to eighth abdominal spicular zones of *neglecta* (fig. 89), but further breeding is required to check this.



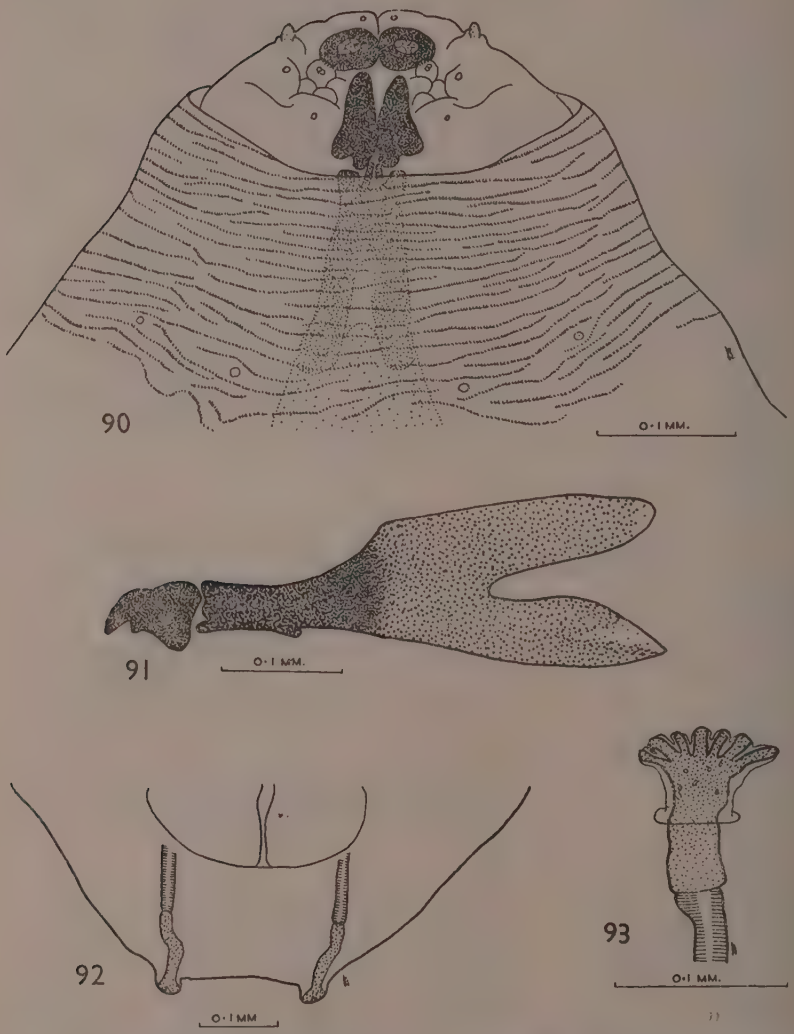




FIGS. 84–87.—*Cetema neglecta* Tonnoir: (84) facial mask; (85) cephalo-pharyngeal skeleton; (86) posterior spiracles; (87) anterior spiracles.



FIGS. 88–89.—*C. neglecta :* spicular zones.



Figs. 90–93.—*Chlorops pumilionis* Bjerkander: (90) facial mask; (91) cephalo-pharyngeal skeleton; (92) posterior spiracles; (93) anterior spiracles.

Chlorops Meigen

(*Oscinis* Latreille)

Chlorops pumilionis Bjerkander

(*C. lineata* Fabricius).
(*C. taeniopus* Meigen).

This species, commonly known as the Gout-fly of barley, can be a serious pest of cereals, particularly on the Continent. Its larva has been described and figured to a greater or lesser extent by Frew (1923), Vimmer (1925), Kreuter (1928), Oettingen (1935), Balachowsky and Mesnil (1935) and Horber (1950).

At Silwood Park the larva has been found overwintering in the basal tillers of barley, rye and *Agropyron repens* L. In common with other species of the genus, this larva does not sever the central shoot causing a dead heart but stimulates the plant to hypertrophy and forms a swollen "gouted" shoot. Pupation occurs in early April; the fly emerges in May and oviposits on the leaves of cereals or wild grasses. The larva feeds on the developing ear or inflorescence and then pupates within the host in July. The second generation of flies emerge in late August or early September and oviposit on their winter hosts.

Third Instar Larva (figs. 90–93)

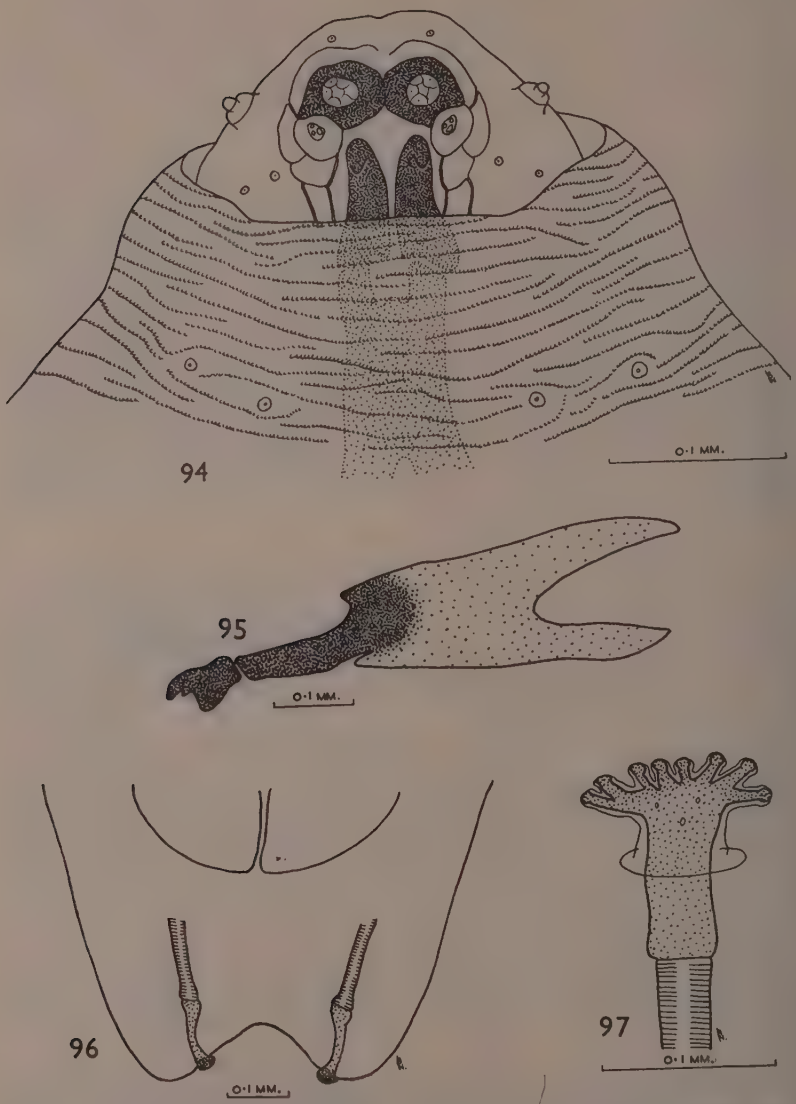
General description.—A relatively immobile but fairly typical acalypterate larva up to 7 mm. long, 1·2 mm. in diameter and mainly white but in parts of the abdominal area the alimentary canal can be clearly seen varying in colour between specimens from olive-green to an orange-brown. Head mainly retracted but maxillary palps appear as a pair of horn-rimmed spectacles above the black cephalo-pharyngeal skeleton. Anterior and posterior spiracles small and indistinct.

Facial mask (fig. 90).—Head and facial mask normally somewhat retracted and for examination usually need to be everted by pressure on the cover-slip above the abdomen. Most prominent features of the mask are maxillary palps of the closed type, with each ring greatly thickened, densely tanned and meeting in the mid-ventral line. Antennae also characteristic since they lie laterally on a level with maxillary palps. Apical segment very lightly tanned. Very few cells formed on the mask and none of the rami lead towards the mouth opening as in other genera, which may perhaps be correlated with the feeding habit, since this species does not appear to be a voracious feeder but rather stimulates the host, which possibly then produces fluid nutrient.

Cephalo-pharyngeal skeleton (fig. 91) densely tanned anteriorly, but becoming paler posteriorly. Consists of the paired mouth-hooks with a moderately sharp apical tooth followed by another blunter one. Intermediate sclerite fused to pharyngeal sclerite which has no dorsal sclerite and is therefore open dorsally. Ventrally, however, area along pharynx lightly tanned.

Anterior spiracles (fig. 93) of the fan type and with a very thick spiracular trunk. Of those examined 6 per cent. had 6 digitations, 38 per cent. had 7, 44 per cent. had 8 and 12 per cent. had 9.

Posterior spiracles (fig. 92) borne on a pair of very small well separated spiracular lobes. No branched hairs present.



FIGS. 94–97.—*Chlorops speciosa* Meigen: (94) facial mask; (95) cephalo-pharyngeal skeleton; (96) posterior spiracles; (97) anterior spiracles.

Spicular zones consisting of numerous overlapping rows of very fine but separate spicules. In third thoracic and all abdominal zones immediately anterior to these rows a broad band of close, scattered, fine spicules present, within which are lacunae containing no spicules.

Ventral distribution :

Zone I :	15–25 overlapping rows of very fine rounded spicules.
Zone II :	15–25 overlapping rows as preceding.
Zone III :	plain band of close, scattered, fine spicules merging into 8–15 overlapping rows of very fine rounded spicules.
Zones 1–8 :	band of close, scattered, fine spicules (containing lacunae with no spicules) merging into 10–30 overlapping rows of very fine rounded spicules (the number of rows increase in the posterior zones).

Chlorops speciosa Meigen

Balachowsky and Mesnil (1935), who have made a special study of this genus, give the only other description of this larva. It overwinters in the basal tillers of *Deschampsia caespitosa* L., and the identification of the bred adult was confirmed by the late Dr. F. I. van Emden.

The posterior spiracles of the larvae found at Silwood Park and described below do not, however, agree with Balachowsky and Mesnil's figure and resemble more those of *C. frontosa* Meig., which lives in *Carex* and has been figured by d'Aguilar (1943). This is likely to be another case of close species (cf. *Oscinella*), the adults of which are being confused while the larvae are more readily separable.

Third Instar Larva (figs. 94–97)

General description.—An elongate white larva, up to 10 mm. long and 1·5 mm. diameter, similar to *C. pumilionis* but posterior spiracular lobes differ as described below.

Facial mask (fig. 94).—Similar to *C. pumilionis* except that antennae even more lateral and frontal palp relatively larger.

Cephalo-pharyngeal skeleton (fig. 95).—Morphologically similar to *C. pumilionis* but dorsal and ventral wings of pharyngeal sclerite only very slightly tanned.

Anterior spiracles (fig. 97) of the fan type with about 8 digitations. Spiracular trunk very broad.

Posterior spiracles (fig. 96).—As mentioned above, spiracles of larvae seen by me differ from those described by Mesnil. Abdomen terminates as 2 broad spiracular lobes separated by a shallow " valley " and posterior spiracles terminate as small brown knobs facing inwards on the sides of this " valley " and not quite terminally.

Spicular zones.—Ventral distribution :

Zone I :	20–30 overlapping rows of fine rounded spicules.
Zone II :	20–30 as preceding.
Zone III :	about 5 irregular overlapping rows of fine rounded spicules followed by a narrow band of closely scattered fine rounded spicules. 15–25 overlapping rows of fine rounded spicules.
Zones 1–8 :	broader band of closely scattered, fine rounded spicules. about 15 overlapping rows of fine spicules increasing to about 40 rows in posterior zones.

Chlorops brevimana Loew.

(*C. fulviceps* Becker).

Larva described and figured by Oettingen (1935) and Balachowsky and Mesnil (1935). The larvae overwinter in basal and aerial shoots of *Phalaris arundinacea* L., pupate in April and emerge in May. These adults give rise to a second generation in August which in their turn produce the overwintering larvae.

Third Instar Larva

General description.—A white larva up to 10 mm. long and 1·5 mm. diameter, similar to *C. pumilionis* but characterised by its elongate posterior spiracular lobes.

Facial mask.—Similar to *C. pumilionis* but area within ring of maxillary palp relatively larger and off-centred, resulting in the ring being thinner on the outside but remaining thick towards the mid-ventral line.

Cephalo-pharyngeal skeleton.—Similar to *C. speciosa* in having dorsal and ventral wings paler and much less tanned than the remainder.

Anterior spiracles.—Similar to *C. pumilionis.*

Posterior spiracles themselves very small brown knobs projecting from the end of a pair of characteristic elongate spiracular lobes which are nearly twice as long as wide and therefore separated by a very deep channel. Very minute hairs present but not branched.

Spicular zones.—Ventral distribution :

Zone I :	25–35 overlapping rows of very fine spicules.
Zone II :	25–35 as preceding.
Zone III :	broad band of close, scattered, rounded spicules merging into 25–35 overlapping rows of very fine spicules.
Zones 1–8 :	similar to Zone III.

Chlorops interrupta Meigen

(*C. hirsuta* Loew).

Larva described and figured by Balachowsky and Mesnil (1935), according to whom its host grasses are of the genus *Agropyron*. There appear to be two generations per year.

Larva characterised by its very small anus and posterior spiracular lobes which each have a thickened tanned edge and are somewhat cup-shaped. The edge bears 3 or 4 large triangular projections.

Chlorops marchali Mesnil

Balachowsky and Mesnil (1935) partly described and figured the larva of this species, whose biology appears to be the same as that of *C. interrupta*.

No details given of facial mask but the posterior is figured. Spiracular lobes similar to those of *C. pumilionis* but anus much smaller, its transverse diameter less than the distance between the posterior spiracular lobes.

Chlorops sp. ex *Festuca*

The larva of this species has been found at Silwood Park overwintering in and causing " gouting " of the basal tillers of *Festuca tenuifolia* Sibth. On submitting some adults bred from these larvae to Mr. J. E. Collin for his

opinion, he wrote that " they appear to be an undescribed species resembling in many respects *calceata* Meig.". Pending the published description and naming of the adults of this species, details of the larvae are given here.

Third Instar Larva

General description.—A white larva with olive-brown to orange mid-gut showing through the cuticle. Up to 5 mm. long and 0·75 mm. diameter and similar in appearance to *C. pumilionis*.

Facial mask very similar to that of *C. speciosa* with antennae low on sides of face. Maxillary palps separated medially. Area within ring containing papillae relatively larger and off-centred, resulting in a thinner ring on the outside but remaining thick towards mid-ventral line.

Anterior spiracles small and of the fan type with about 4 digitations.

Posterior spiracles very similar to those of *C. speciosa*.

Spicular zones.—Ventral distribution :

Zone I :	15–20 overlapping rows of fine rounded spicules which merge into Zone II.
Zone II :	30–40 overlapping rows as preceding which merge into Zone III.
Zone III :	30–40 overlapping rows as preceding which merge into Zone 1.
Zones 1–3 :	a narrow band of close, scattered extremely fine spicules merging into about 40 overlapping rows of fine rounded spicules ; in Zones 1 and 2 these merge with the next zone but by the end of Zone 3 there is a clear unornamented area between the zones.
Zones 4–8 :	about 5 overlapping rows of fine rounded spicules merging into a band of close scattered extremely fine spicules ; about 40 overlapping rows of fine spicules.
Anal zone :	about 5 short overlapping rows of fine spicules anterior to anus.

Chloropisca Loew

Chloropisca glabra Meigen

(*C. assimilis* Macquart).
(*C. lineata* Meigen).

This species does not strictly fall within the title of this paper but is mentioned since its larva may be found in association with the Gramineae as a predator on root feeding aphids. Balachowsky and Mesnil (1935) give the only larval description and figures.

Larvae characterised by their elongate thoracic segments, the absence of rami from the facial mask and their antenna, the apical segment of which is almost hemispherical and larger than the ring of the maxillary palp. Distinguished from *Thaumatomyia notata* Zett. by the presence mid-ventrally of the lines of spicules of all spicular zones.

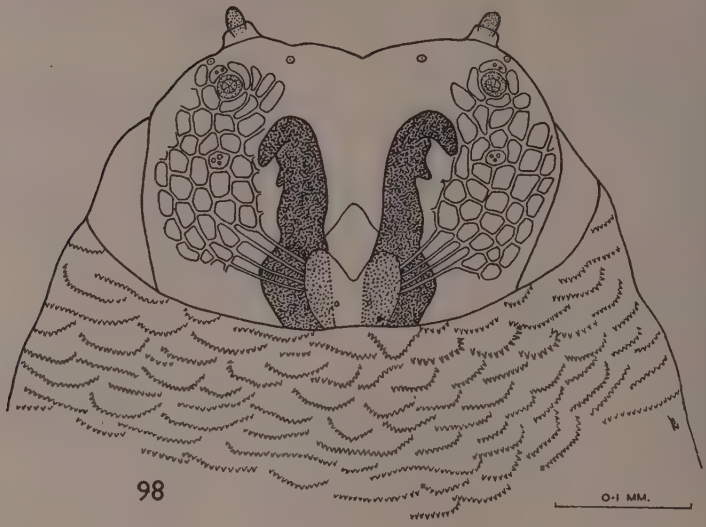
Thaumatomyia Zenker

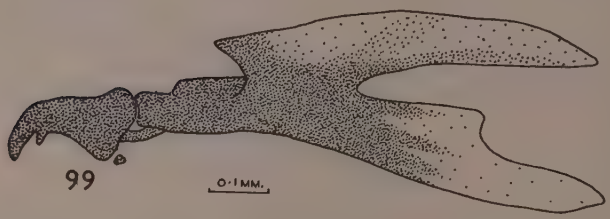
Thaumatomyia notata Zetterstedt

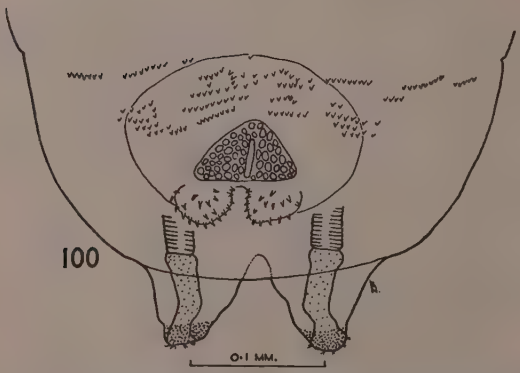
(*T. circumdata* Meigen).
(*T. ornata* Loew).

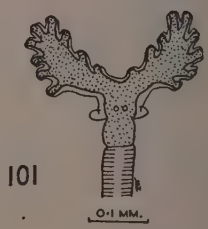
This species has the same habit and is very similar to *Chloropisca glabra* Meig. It has been briefly described by Balachowsky and Mesnil (1935).

Distinguished from *C. glabra* by the disappearance mid-ventrally of the lines of spicules of meso- and metathoracic and first abdominal spicular zones.









FIGS. 98–101.—*Amaurosoma armillatum* Zetterstedt: (98) facial mask; (99) cephalopharyngeal skeleton; (100) posterior spiracles; (101) anterior spiracles.

(6) Cordiluridae

Amaurosoma Becker

Amaurosoma armillatum Zetterstedt

Amaurosoma flavipes Fallén

These two species have the same habit and Karpova (1930), who has studied both, considers that they are almost indistinguishable in the immature stages. Barnes (1935) reviewed the literature and King, Meikle and Broadfoot (1935) have in part described *A. armillatum*. Kreuter (1928) and Oettingen (1935) have both very briefly described and figured *A. flavipes*. Balachowsky and Mesnil (1935) give a description and illustration under the name *Trichopalpus punctipes* Meig., which they state is a synonym of *A. flavipes*, but which is in fact a different species. Their description could, however, apply to *Amaurosoma*.

These species overwinter as pupae and emerge in mid-May. They then oviposit on the upper leaves of *Phleum pratense* L. (Timothy Grass) and the larvae feed on the inflorescence. When mature they migrate or drop to the ground and pupate. There is only one generation per year. At Silwood Park both species were bred from plots of Timothy Grass but the larvae cannot yet be distinguished.

Third Instar Larva (figs. 98–101)

General description.—A yellow, typically calypterate larva up to 6·5 mm. long and 1·5 mm. diameter. Antennae and maxillary palps just visible as 4 spots above the dark cephalo-pharyngeal skeleton. Anterior spiracles conspicuously characteristic, being double branched and antler-like. Posterior spiracular lobes lightly tanned at the tips.

Facial mask (fig. 98).—Maxillary palps of the closed ring type, lightly tanned and very widely set on the face. A large mid-frontal area containing no rami. Antennae, with apical segment lightly tanned, project directly anterior to maxillary palps and are widely separated. A series of unornamented cells present between maxillary and inconspicuous frontal palps and continuing into genal area, finally anastomosing to about 4 genal rami leading to mouth opening.

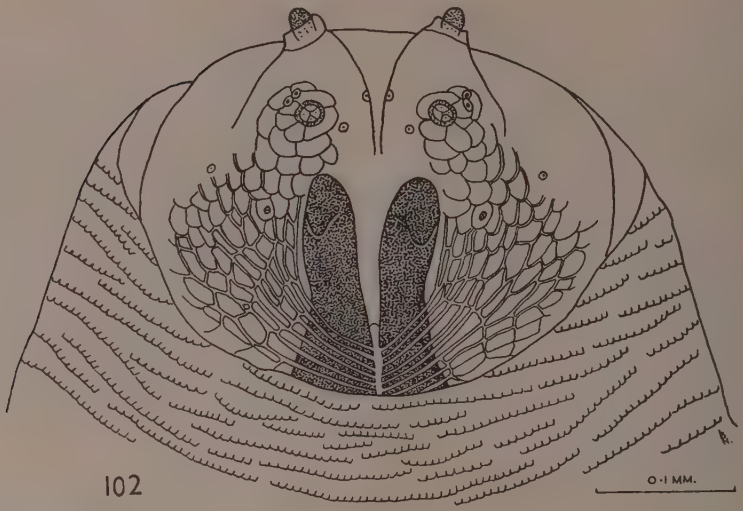
Cephalo-pharyngeal skeleton (fig. 99).—Mouth-hooks with strong apical tooth followed by one only, slightly smaller. Pair of small dentate sclerites present. Prominent liguloid plates present between intermediate sclerites, which latter are partially fused with pharyngeal sclerite. Dorsal and ventral wings of pharyngeal sclerite only partially tanned.

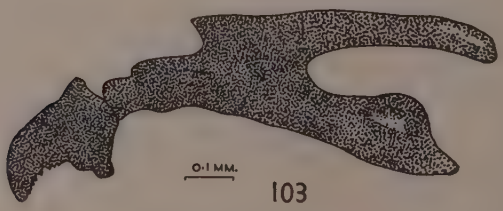
Anterior spiracles (fig. 101) very distinctive and of a double-branched type, having an antler-like appearance. Each branch with about half the total number of digitations; of those examined 10 per cent. had a total of 14 digitations on the two branches, 10 per cent. had 15, 30 per cent. had 16, 35 per cent. had 17 and 15 per cent. had 18.

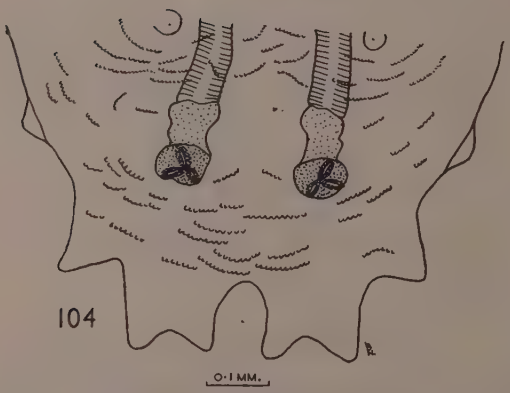
Posterior spiracles (fig. 100).—Anal segment terminating in a pair of membranous spiracular lobes, the tips of which lightly tanned. Some minute unbranched hairs present.

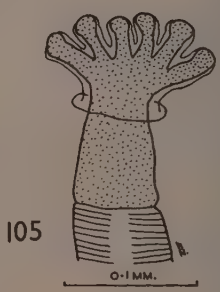
Spicular zones.—Ventral distribution:

Zone I:	6–10 irregular broken rows of short crescentic groups of coarse pointed spicules.
Zone II:	4–6 as preceding.
Zone III:	2–4 as preceding.
Zones 1–8:	about 5 very irregular rows of short groups and scattered coarse pointed spicules.
Anal zone:	anus itself situated in centre of a triangular reticulated area anterior to which are scattered groups of coarse pointed spicules which are really part of Zone 8; posterior to anus a characteristic pair of projecting hemispherical lobes, covered in coarse pointed spicules.









Figs. 102–105.—*Leptohylemyia coarctata* Fallén: (102) facial mask; (103) cephalopharyngeal skeleton; (104) posterior spiracles; (105) anterior spiracles.

(7) Muscidae

Leptohylemyia Schnabl and Dziedzicki

Leptohylemyia coarctata Fallén

This species, the Wheat Bulb Fly, is a serious pest of cereals. The first supposed description of its larva was by Kurdjumov (1914), but Keilin (1917) has shown that the cephalo-pharyngeal skeleton illustrated belongs to a carnivorous larva. Subsequently partial descriptions and illustrations have been given by Morris (1925), Puri (1925), Kreuter (1928), Oettingen (1935), Balachowsky and Mesnil (1935) and Kéler (1943).

The species overwinters as eggs which have been laid on bare soil during July and August. They hatch in February and the larva wanders in search of a cereal (usually wheat in this country) or wild grass, in the tillers of which it develops. Pupation takes place in the soil about the beginning of May and the flies emerge in June.

Third Instar Larva (figs. 102–105)

General description.—A white typically calypterate larva up to 7 mm. long and 1 mm. diameter. Antennae and maxillary palps just visible as 4 small spots above the dark cephalo-pharyngeal skeleton. Anterior spiracles of the fan type. Anal segment characteristically truncate and bearing a series of membranous lobes, the mid-ventral pair being bifid.

Facial mask (fig. 102). –Head anteriorly divided by a deep median furrow into halves, each surmounted by an antenna lightly tanned apically. Maxillary palps of the closed ring type and also lightly tanned. Mid-frontal area bare but frontal and genal areas covered with numerous unornamented cells which arise from about 6 genal rami.

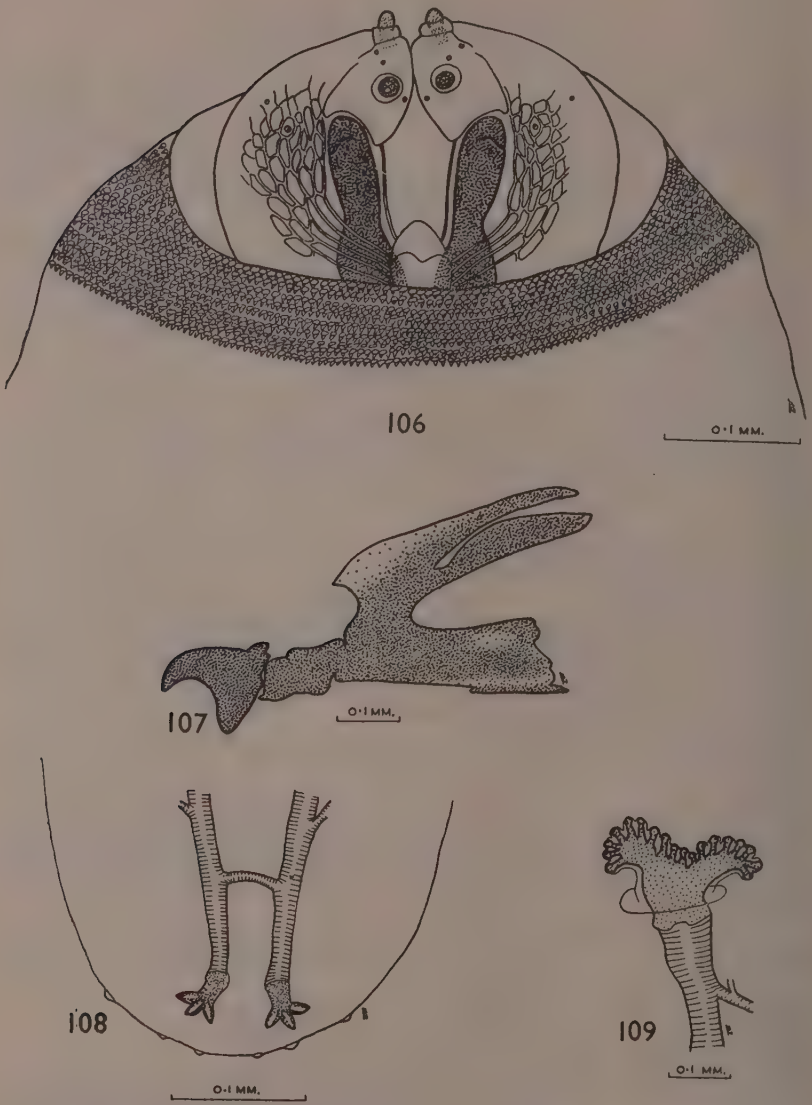
Cephalo-pharyngeal skeleton (fig. 103).—A robust apical tooth followed by a series of about 6 smaller ones. A pair of very small dentate sclerites, and prominent liguloid plates present. Intermediate sclerite fused to pharyngeal sclerite which, in common with rest of skeleton, is densely tanned throughout.

Anterior spiracles (fig. 105).—Of the fan type with a very wide spiracular trunk. Of those examined 19 per cent. had 6 digitations, 53 per cent. had 7, 22 per cent. had 8 and 6 per cent. had 9.

Posterior spiracles (fig. 104).—Anal segment truncated with a series of membranous lobes around edge of truncation. A large bifid lobe on either side of mid-ventral line and between this and mid-dorsal line are 3 separate single lobes, becoming progressively smaller. Posterior spiracles tanned and borne centrally on the truncated area. No spiracular hairs present.

Spicular zones.—Ventral distribution :

Zone I :	8–12 irregular broken rows of linearly grouped coarse broadly rounded spicules.
Zone II :	6–10 irregular broken rows as preceding.
Zone III :	4–8 irregular broken rows as preceding.
Zone 1 :	4–8 irregular broken rows as preceding.
Zones 2–7 :	2–4 irregular broken rows as preceding, followed by an area in which short rows of similar spicules are arranged very roughly in concentric semicircles; 2–4 irregular broken rows of linearly grouped coarse broadly rounded spicules.
Zone 8 :	consists of spicules associated with the very broad anus ; closely set short groups of coarse rounded spicules present anteriorly ; posteriorly longer groups as preceding.



FIGS. 106–109.—*Phorbia genitalis* Schnabl and Dziedzicki: (106) facial mask; (107) cephalo-pharyngeal skelton; (108) posterior spiracles; (109) anterior spiracles.

Delia Robineau-Desvoidy

(*Crinura* Schnabl)

(*Chortophila* Macquart)

Delia cilicrura Rondani.

The larva of this species has been described and figured by Balachowsky and Mesnil (1935). On the Continent the adults oviposit near young winter cereals in which the larvae develop ; the adults then emerge in April and often oviposit near spring cereals in which the larvae develop. There may be yet another generation between this and the autumnal oviposition, but this is not certain.

I have not seen the larva of this species.

Larva posteriorly truncate and bears 12 membranous lobes (none being bifid) around the truncation. A series of about 3 lines of crescentic groups of fine spicules on facial mask between maxillary and frontal palps.

Phorbia Robineau-Desvoidy

(*Chortophila* Macquart)

Phorbia genitalis Schnabl and Dziedzicki

This species can be a serious pest of wheat on the Continent and its immature stages have been partly figured by Kurdjumov (1914), Mesnil and Pétré (1932), Oettingen (1935), Balachowsky and Mesnil (1935) and Stork (1936). The larva of *P. sepia* Meig. has been briefly described by Vimmer (1925).

Overwintering is in the pupal stage and emergence of the fly takes place about mid-April. The adult oviposits on cereals, most commonly wheat, or wild grasses—at Silwood Park on *Holcus lanatus* L. Development is completed by mid-June and the larvae then pupate. A second generation of larvae were found in *H. lanatus* in September ; these pupated in October.

Third Instar Larva (figs. 106–109)

General description.—A white calypterate larva up to 7 mm. long and 1·2 mm. diameter, often with a brown alimentary canal showing through posterior half of abdomen. Antennae and maxillary palps just visible as 4 brown spots above the black cephalo-pharyngeal skelton. Anterior spiracles conspicuous and of the double rosette type. Posteriorly the abdomen very slightly truncate and the prominent posterior spiracles light brown.

Facial mask (fig. 106).—Head anteriorly divided into halves, each surmounted by a very lightly tanned antenna. Maxillary palps of the closed ring type, also lightly tanned and borne on a large plain area extending from the antennae to the widely separated mouth-hooks. Frontal and genal areas covered in unornamented cells arising from about 5 pairs of genal rami.

Cephalo-pharyngeal skeleton (fig. 107) relatively foreshortened and densely tanned. Mouth-hooks with a strong apical tooth but no others. Intermediate sclerites short ; anterior to hypostomal arch the liguloid plates elongate and reaching forward between the mouth-hooks. Each of dorsal wings of pharyngeal sclerite subdivided into 2 processes.

Anterior spiracles (fig. 109) of double rosette type, each with about half the total number of digitations. Of those examined 4 per cent. had a total of 16 digitations, 10 per cent. had 17, 30 per cent. had 18, 44 per cent. had 19 and 12 per cent. had 20.

Posterior spiracles (fig. 108) not borne on membranous spiracular lobes ; the lightly tanned spiracular trunks open posterodorsally on anal segment. The 3 peritremes elliptical and prominent.

Spicular zones.—Ventral distribution :

Zone I :	8–12 rows of closely packed pointed spicules each with a rounded base.
Zone II :	5–8 rows of linearly grouped very coarse rounded spicules.
Zone III :	3–5 rows as preceding.
Zones 1–8 :	3–4 rows as preceding, reducing to a single row in the posterior zones.

VII. Discussion

The cyclorrhaphous larvae living in the Gramineae have a general uniformity of appearance and although Frew (1923), Steel (1931) and Thomas (1933 *et seq.*) have illustrated the facial mask and abdominal spicules of a few British species, the majority of authors in any attempted description have concentrated almost exclusively on the cephalo-pharyngeal skeleton and the anterior and posterior pairs of spiracles. It was Mesnil (1934) and Balachowsky and Mesnil (1935) who demonstrated the real value of the microcuticular structures of this group in identifying closely related species and who pointed out that in some cases it is easier to separate the larvae than the adults. This has been borne out by the present study of *Oscinella* larvae, which shows that the somewhat variable species *O. frit* must be regarded as a complex yet to be resolved. The relationships between the larvae of this genus and the known varieties of *frit* adults have already been reported (Jepson and Nye, 1957). Recently Nartshuk (1956) has carried out a similar study of the *Oscinella* species in Russia.

With the work of Cook (1949) the evolutionary trends exhibited in the dipterous larvae have been greatly clarified, and Ludwig (1949) has sorted out much of the embryology and morphology of the cyclorrhaphous head, but there still remains a vast field for research into the phylogeny and derivation of its tissues. One of the taxonomically important structures the origin of which has yet to be studied is the frontal palp. Is this an offshoot of the maxillary palp or has it become separated from its main sclerite, being really of labial origin? The evidence so far tends to be against the latter possibility, but it is by no means final.

The rami of the facial mask present further problems. Is their function to assist in the rasping and channelling of food? If so, why should the reticulation be so reduced in some species and so much more complex in others in identical habitats? The masks and other larval characters of species within a genus are very similar, but the work of Hennig (1948–52) on the known larvae of the Diptera shows that insufficient genera have so far been studied in adequate detail to link them into family relationships.

The functions of the antennae, palps and papillae all still remain to be determined. On hatching, the eggs are frequently already on the plant but sometimes they are laid or washed on to the soil nearby ; in the latter case and during vertical migration of the larvae from ploughed-in grasses, do the larvae find their way to a host and to its central shoot by random wandering ? If not, to what and with what do they respond? Stokes (1957) has shown that there is, in fact, evidence for the existence of a directional response towards a wheat root diffusate in the case of *Leptohylemyia coarctata* larvae.

Once the means for accurate larval determination are available, ecological investigation into the distribution and populations of the species among grasses

in the field can be continued without the necessity of breeding out all the larvae found. A concurrent study on these lines has already been started and the results obtained from leys in Berkshire are being prepared for publication.

VIII. Summary

1. A general illustrated description of the cyclorrhaphous larvae found as shoot flies in British cereals and grasses is given. Particular attention has been paid to the cephalo-pharyngeal skeleton, the anterior and posterior spiracles and the taxonomically important micro-cuticular structures of the head, thorax and abdomen.

2. A key to the larvae of 41 species is included.

3. Strictly comparative illustrations and descriptions of the larvae included in the key are given. A special study has been made of *Oscinella* spp.

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